Assessment of asthma-prone environment in Karachi, Pakistan using GIS modeling

Imran Ahmed Khan,1 Mudassar Hassan Arsalan,2 Mohammed Raza Mehdi,3 Jamil Hasan Kazmi,4 Jeong Chang Seong,5 Daikwon Han6

Abstract

Objectives: To determine the association among number of factors influenced by asthma using geographic information system.

Methods: The cross-sectional study was conducted in Landhi and Korangi towns of Karachi from 2011 to 2013, and comprised ecological mapping and multi-criteria evaluation techniques to discover the relationship of local environmental settings with asthma. Additionally, exacerbating environment and the root causes within the local settings were assessed. Data was gathered using an extended version of the questionnaire developed by the International Union against Tuberculosis and Lung Disease. Data was analysed by using ArcGIS 10.

Results: The findings are very alarming as almost 40% (468,930 estimated pop 1998 census) of the study population lived in high asthma-prone environment, having a very high risk of respiratory disorders, including asthma.

Conclusion: The integrated environmental effect in the form of respiratory disorders was appraised, focusing on asthma by using multi-criteria analysis.

Keywords: Asthma, Asthma in Karachi, Geospatial, Risk assessment, GIS modelling, Multi-criteria evaluation, Asthma in LDCs. (JPMA 70: 636; 2020) https://doi.org/10.5455/JPMA.11828

Introduction

Asthma is a serious global health problem as people of all age groups, colours, geographic locations and socioeconomic groups all over the world are affected by this chronic disorder which is sometimes fatal for the patients. The estimated number of patients with asthma has doubled throughout the world during the last two decades.1 Due to unhygienic living and working environments, the poor, especially industrial workers, are more prone to this disorder than others.2 The asthma prevalence is increasing in the urban areas of Pakistan. About 10% population of Pakistan’s largest city Karachi has chronic asthma.3,4

New technological innovations always bring changes in science- and health-related research. Statistical- and computer-based spatial modelling helps in discovering new dimensions of facts.5 Ecology and aetiology of disease has become much easier to understand with the growth of new technologies.6-8 Many studies indicate the potential of geographic information system (GIS) and its allied technologies to investigate the relationship between environmental factors and frequency of diseases.9-11 GIS has become an essentially integral part of community health systems that is used for the representation and analysis of disease data in a map form in many parts of the world.12-18

The aetiology of asthma varies considerably from person to person. Typical asthma triggers are outdoor air pollution, indoor allergens, pollens, family history, and behavioural causes, such as cigarettes.19-26 Researchers have explored the link between outdoor air pollution and asthma in an urban environment,27-32 and have demonstrated that the exposure to major air pollutants, including ozone, sulphur dioxide, nitrogen dioxide, and suspended particulate matter, is related to high asthma prevalence and the rate of hospitalisation.33-42

The causes of asthma are uncertain and localised.43,44 Though we already know that, there is still more to be learned about what causes and exacerbates the asthma, we know that a number of factors can influence this disease as a lot of studies advocated, including the indoor and outdoor environment.45,46 There is an idea that environmental conditions may contribute to asthma occurrences.47-49

The current study was planned to use GIS to determine
the association among the spatial dimensions of asthma and its environmental controlling factors in Karachi.

**Materials and Methods**

The cross-sectional study was conducted in Landhi and Korangi towns of Karachi from 2011 to 2013. Based on literature review, a list of asthma environmental triggers\(^{50-140}\) were compiled (Table-1) that helped in designing the study and preparing environmental parameters having proven relationship with asthma (Figure-1).

Karachi, the mega city of Pakistan, is administratively divided into 18 towns and cantonment areas. For detailed field investigation and environmental data collection, Landhi Town and Korangi Town were selected. These towns are further divided in 21 union councils (UC), which is the smallest administrative unit in Pakistan. Both adjacent towns represent the typical environment and living conditions of Karachi (Figure-2).

For collecting environmental data, QuickBird satellite imagery was used from Google Earth to develop the digital base maps of the study area on a larger scale of 1:5,000 by using ArcGIS 10 software that mainly consists of roads, points of interests (POIs) and land use / land cover (LULC). Published administrative maps of the City District Government Karachi (CDGK) were also used to define the administrative boundaries, which are digitised as vector layers.

Asthma prevalence and the socio-environmental conditions were appraised through an in-depth questionnaire. The instrument used was an extended version of the questionnaire developed by the International Union against Tuberculosis and Lung Disease (IUATLD) for such diseases validated by a pioneer study.\(^{141}\) The IUATLD questionnaire is focussed on the investigation of asthma prevalence in the community. However, we extended the questionnaire by adding socio-environmental questions.\(^{50-140}\)

A few research assistants were trained for data collection, and pilots were run to improve the content of the questionnaire, avoid errors/omissions and to get effectiveness of results. Almost 80% interviewers were female who were a great help in executing the questionnaire in the selected study area due to cultural sensitivities.

Every effort was made to cover diversity in environmental settings, including planned and slum neighbourhoods, proximity to industrial units, and roadside retail outlets. For managing field execution, stratified random sampling was employed with a sample size of 0.1% of the total respondents (n=987). Households of each UC were considered for preparing spatially location-based distributed sample size that was mapped and analysed thereafter.

Informed consent was obtained from the subjects as the questionnaire was explained in both verbal and written forms in Urdu, the native language, and validated prior to execution by a translation expert. The identity of individuals and data storage was maintained confidentially as per the guidelines of the Departmental Research Committee (DRC), Department of Geography, and University of Karachi.

Besides qualitative survey, ambient air, drinking water and surface soil were analysed to trace the air pollutants and heavy metals. These included carbon monoxide (CO), sulphur dioxide (SO2), nitrogen oxide (NO), nitrogen

**Table-1:** Parameters and variables used in asthma prone modelling.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indoor environment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Rats &amp; cockroaches</td>
<td>(^{30-98})</td>
</tr>
<tr>
<td></td>
<td>ii. Plants</td>
<td>(^{51-95})</td>
</tr>
<tr>
<td></td>
<td>iii. Pets</td>
<td>(^{45-96})</td>
</tr>
<tr>
<td></td>
<td>iv. Energy source</td>
<td>(^{27-59})</td>
</tr>
<tr>
<td></td>
<td>v. Active/passive Smoking</td>
<td>(^{29,100-102})</td>
</tr>
<tr>
<td></td>
<td>vi. Ventilation</td>
<td>(^{103-105})</td>
</tr>
<tr>
<td></td>
<td>vii. Carpets</td>
<td>(^{30-108})</td>
</tr>
<tr>
<td></td>
<td>Environmental Pollution</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Air pollutants</td>
<td>(^{100-111})</td>
</tr>
<tr>
<td></td>
<td>ii. Water Pollutants</td>
<td>(^{112-114})</td>
</tr>
<tr>
<td></td>
<td>iii. Soil Pollutants</td>
<td>(^{115-117})</td>
</tr>
<tr>
<td></td>
<td>Asthma Aetiology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Symptoms</td>
<td>(^{118-120})</td>
</tr>
<tr>
<td></td>
<td>ii. Type of disease</td>
<td>(^{121,122})</td>
</tr>
<tr>
<td></td>
<td>iii. Causes of disease</td>
<td>(^{123-125})</td>
</tr>
<tr>
<td></td>
<td>iv. Consultation</td>
<td>(^{126-128})</td>
</tr>
<tr>
<td></td>
<td>v. Reason of symptoms/ Difficulty in respiration</td>
<td>(^{129-132})</td>
</tr>
<tr>
<td></td>
<td>vi. Time period/Duration</td>
<td>(^{133-135})</td>
</tr>
<tr>
<td></td>
<td>vii. Specific reason of disease</td>
<td>(^{136-140})</td>
</tr>
</tbody>
</table>
dioxide (NO₂), nitrogen oxides (NOₓ), total suspended particles (TSPs), lead (Pb) and cadmium (Cd) for air, and for the soil and water, toxic elements like Pb, Cd, arsenic (As) and mercury (Hg). Soil and water data was collected from 12 selected locations, which are distributed in residential, industrial and commercial areas, whereas air was analysed at 10 sample locations on major road intersections and industrial areas.

Multi-criteria evaluation (MCE) technique was used to assess the asthma-prone environment. This technique uses the spatial relationships among variables that increase the
interpretability of spatial information.\textsuperscript{142,143}

We utilised the weighted sum function in ArcGIS\textsuperscript{10} in the spatial analyst tool.\textsuperscript{143,148} It utilises the following equation to assess the weighted sum:

\[ R = \sum W_i x_i \]  \hspace{1cm} (1)

Where $R$ = Risk; $W_i$ = weight of factor $i$; and $X_i$ = standardised score of factor $i$.

The adopted analytical techniques were already implemented by studies in both developed and developing countries.\textsuperscript{144-148}

Based on literature search, we prepared multiple parameters for a combined, asthma-prone appraisal system. Initially, more than 200 socio-environmental variables were developed and tested in relation to the prevalence of asthma in the study area (Figure-3). The collected data
was compiled on a standard template in MS Excel to extract statistical results, i.e., correlation, frequencies of data, etc. ArcGIS 10 software was used to generate interpolated surfaces for each data layer, which was later summarised for each UC. However, we tested their relationship with asthma prevalence by calculating Spearman’s coefficient correlation. As per our threshold selection criteria (i.e. $r>0.3$ or $r<0.3$) ($p<0.05$), 32 variables established their significant relationship with the prevalence of asthma and were finalised for using in MCE in the form of spatial overlays. The strength of correlations was prioritised among standardised criterion variables regardless of

---

**Figure-4:** Asthma-prone environment divisions.

**Figure-5:** (a) Asthma Clinics Distribution (b) Buffer of Potential Patient Coverage (c) Zonal Statistics by Overlay Analysis (d) Evaluated Asthma outpatient department (OPD) (e) Normalised Asthma OPD.
the direction. Hence, two-tailed Spearman’s correlation method was applied. All variables demonstrated their strength of interaction on spatial canvas. We utilised the total sum and weighted them according to their respective proportions for final risk assessment. Weights are assigned to each criterion variable (overlays) as an indication of the intended contribution of that layer.

MCE analysis procedures require the standardisation of dataset values. We normalised data in two steps. First, we converted all the selected variables into measurement per acre. In the second step, we re-scaled the value of each variable with a value range of 1 to 10, where 1 represents the lowest and 10 the highest for consideration of risk. The ranges of possible values were divided into 10 groups, so that the each group contains the same range of frequencies. This grouping method was useful to focus variation in the middle values of the distribution, because the intervals are usually wider at the extremes.149-151

The outcome of risk evaluation was validated through field measurements of asthma outpatient departments (OPDs) for 24 months duration from major hospitals and clinics. The obtained results were validated by asthma OPD data from various local hospitals and clinics. Model validation was done in 5 steps: Asthma OPD data was obtained from hospitals and clinics with patient addresses; locations of asthma patients were geo-coded using their addresses; UC-wise asthma patients’ density was calculated to have normalised value (asthmatics per unit area); level of asthma-prone environment was visually compared with the monitored asthma patients in all UCs; and, finally, comparing asthma-prone environment in UCs and OPD statistics, almost similar areas emerged, suggesting that the model of asthma assuming areas stood verified (Figures-5-6).  

**Results**

There was a strong positive correlation among asthma prevalence with land cover, like vegetation, toxic elements, like Pb and Cd, poisonous gases, especially CO, and socioeconomic variables like household density and occupation (Table-2). Asthma prevalence was occurring in densely inhabited area, especially near commercial streets and busy roads of Landhi and Korangi towns. Spatial distribution of the appraised areas among UCs.
## Table-2: Finalised overlay grids.

<table>
<thead>
<tr>
<th>Grid Name</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Land-cover Classification Grid (LCCG)</td>
<td>0.481*</td>
</tr>
<tr>
<td>2. Land-Use Classification Grid (LUCG)</td>
<td>-0.454*</td>
</tr>
<tr>
<td>3. Averages of CO Grid (ACOG)</td>
<td>0.671**</td>
</tr>
<tr>
<td>4. Averages of SO2 Grid (ASO2G)</td>
<td>0.488*</td>
</tr>
<tr>
<td>5. Averages of NO Grid (ANOG)</td>
<td>0.471*</td>
</tr>
<tr>
<td>6. Averages of NO2 Grid (AN02G)</td>
<td>0.476*</td>
</tr>
<tr>
<td>7. Averages of Dust Grid (ADDG)</td>
<td>0.705**</td>
</tr>
<tr>
<td>8. Averages of Cd in Dust Grid (ACdDG)</td>
<td>0.711**</td>
</tr>
<tr>
<td>9. Averages of Pb in Dust Grid (APbDG)</td>
<td>0.725**</td>
</tr>
<tr>
<td>10. Averages of Cd in soil Grid (ACdSG)</td>
<td>0.705**</td>
</tr>
<tr>
<td>11. Averages of As in water Grid (AAWG)</td>
<td>0.650**</td>
</tr>
<tr>
<td>12. Averages of Cd in soil Grid (ACdSG)</td>
<td>0.753**</td>
</tr>
<tr>
<td>13. Averages of Pb in soil Grid (APbSG)</td>
<td>0.701**</td>
</tr>
<tr>
<td>14. Intensity of Kitchen fumes in house Grid (KFIG)</td>
<td>0.815**</td>
</tr>
<tr>
<td>15. Intensity of No or low ventilation in house Grid (VNoG)</td>
<td>0.753**</td>
</tr>
<tr>
<td>16. Intensity of Dampness Grid (DamG)</td>
<td>0.893**</td>
</tr>
<tr>
<td>17. Rats Intensity Grid (RatG)</td>
<td>0.801**</td>
</tr>
<tr>
<td>18. Roaches Intensity Grid (RoCG)</td>
<td>0.753**</td>
</tr>
<tr>
<td>19. Indoor Plants Intensity Grid (PlantG)</td>
<td>0.734**</td>
</tr>
<tr>
<td>20. Domestic Birds Intensity Grid (BirdG)</td>
<td>0.704**</td>
</tr>
<tr>
<td>21. Risky Occupation Intensity Grid (RocOcG)</td>
<td>0.882**</td>
</tr>
<tr>
<td>22. Boring Water utilization Grid (BorWg)</td>
<td>0.32</td>
</tr>
<tr>
<td>23. Municipal Water utilization Intensity Grid (OTHWg)</td>
<td>0.523*</td>
</tr>
<tr>
<td>24. House Holds Density Grid (HhOdg)</td>
<td>0.760**</td>
</tr>
<tr>
<td>25. Tobacco Addicts Intensity Grid (TobAddG)</td>
<td>0.44</td>
</tr>
<tr>
<td>26. Density of Houses less than 120 sqyds Grid (HL120G)</td>
<td>0.760**</td>
</tr>
<tr>
<td>27. Allergy Rhinitis Distribution Grid (ARDg)</td>
<td>0.449*</td>
</tr>
<tr>
<td>28. Bronchitis Distribution Grid (BrDG)</td>
<td>0.755**</td>
</tr>
<tr>
<td>29. COPD Distribution Grid (COpdDG)</td>
<td>0.593**</td>
</tr>
<tr>
<td>30. Tb Distribution Grid (TbDG)</td>
<td>0.481*</td>
</tr>
<tr>
<td>31. Lung Cancer Distribution Grid (LuCDG)</td>
<td>0.331*</td>
</tr>
<tr>
<td>32. Asthma Distribution Grid (AsDG)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

## Table-3: Weighted sum and asthma indices with risk potential.

<table>
<thead>
<tr>
<th>UCs</th>
<th>Area (acres)</th>
<th>Population</th>
<th>Asthma Prevalence (%)</th>
<th>Weighted Sum</th>
<th>Risk</th>
<th>Population proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burmese Colony</td>
<td>143</td>
<td>53,043</td>
<td>9</td>
<td>8</td>
<td>Very HIGH Risk</td>
<td>40%</td>
</tr>
<tr>
<td>Korangi</td>
<td>325</td>
<td>61,309</td>
<td>6</td>
<td>5</td>
<td>Very HIGH Risk</td>
<td></td>
</tr>
<tr>
<td>Sherabad</td>
<td>346</td>
<td>62,071</td>
<td>10</td>
<td>5</td>
<td>Very HIGH Risk</td>
<td></td>
</tr>
<tr>
<td>Mustafa Taj Colony</td>
<td>410</td>
<td>59,579</td>
<td>9</td>
<td>4</td>
<td>Very HIGH Risk</td>
<td></td>
</tr>
<tr>
<td>Gulzar Colony</td>
<td>428</td>
<td>63,474</td>
<td>11</td>
<td>4</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td>Moinabad</td>
<td>221</td>
<td>44,996</td>
<td>21</td>
<td>4</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td>Sector 33</td>
<td>510</td>
<td>61,661</td>
<td>6</td>
<td>4</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td>Muzafarabad</td>
<td>337</td>
<td>62,797</td>
<td>14</td>
<td>4</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td>Khawaja Ajmeer Colony</td>
<td>451</td>
<td>61,326</td>
<td>2</td>
<td>3</td>
<td>Medium Risk</td>
<td>18%</td>
</tr>
<tr>
<td>Landhi</td>
<td>721</td>
<td>53,196</td>
<td>5</td>
<td>3</td>
<td>Medium Risk</td>
<td></td>
</tr>
<tr>
<td>Muslim Abad</td>
<td>466</td>
<td>42,307</td>
<td>16</td>
<td>3</td>
<td>Medium Risk</td>
<td></td>
</tr>
<tr>
<td>Zaman Town</td>
<td>495</td>
<td>60,408</td>
<td>3</td>
<td>3</td>
<td>Medium Risk</td>
<td></td>
</tr>
<tr>
<td>100 Quarters</td>
<td>789</td>
<td>57,867</td>
<td>8</td>
<td>3</td>
<td>Low Risk</td>
<td>19%</td>
</tr>
<tr>
<td>Hasrat Mohani Colony</td>
<td>897</td>
<td>58,084</td>
<td>9</td>
<td>3</td>
<td>Low Risk</td>
<td></td>
</tr>
<tr>
<td>Awami Colony</td>
<td>1745</td>
<td>60,660</td>
<td>15</td>
<td>2</td>
<td>Low Risk</td>
<td></td>
</tr>
<tr>
<td>Chakra Goth</td>
<td>785</td>
<td>61,184</td>
<td>9</td>
<td>2</td>
<td>Low Risk</td>
<td></td>
</tr>
<tr>
<td>Bhiutto Nagar</td>
<td>1034</td>
<td>54,110</td>
<td>9</td>
<td>2</td>
<td>Very Low Risk</td>
<td>23%</td>
</tr>
<tr>
<td>Bilal Colony</td>
<td>2914</td>
<td>62,449</td>
<td>6</td>
<td>2</td>
<td>Very Low Risk</td>
<td></td>
</tr>
<tr>
<td>Dadu Chorangi</td>
<td>748</td>
<td>61,787</td>
<td>13</td>
<td>2</td>
<td>Very Low Risk</td>
<td></td>
</tr>
<tr>
<td>Nazir Colony</td>
<td>1079</td>
<td>61,798</td>
<td>4</td>
<td>2</td>
<td>Very Low Risk</td>
<td></td>
</tr>
<tr>
<td>Sharafi Goth</td>
<td>952</td>
<td>49,146</td>
<td>12</td>
<td>2</td>
<td>Very Low Risk</td>
<td></td>
</tr>
</tbody>
</table>

Suggested that almost 40% of the study population were living in the extremely vulnerable area (Table-3).

There were extremely high asthma risks in the centre of the study area that comprised the densely populated administrative units. Besides population density, most commercial area, educational and entertainment facilities and one of the most important explanations may be a high density of traffic as this region, having most frequent used road by the name of 12000 (road name), is positioned as the hub of the entire study area. Many urban commercial activities were located in this region. This region, having iron and wood markets as well, had respiratory diseases including asthma.

Various factors such as exposure to ambient environment, inappropriate land use, illegal economic activities, loose enforcement of city codes, and limited utility services contributed to asthma in the study area. Timber manufacturing facilities, such as milling and production of
Figure 7: Unhygienic environmental conditions and high population density promoting the respiratory diseases.
Assessment of asthma-prone environment in Karachi, Pakistan using GIS modeling

644

Discussion

Recently, asthma prevalence is increasing among all age groups throughout the world. Karachi, the biggest city of Pakistan, is also facing the resurgence of asthma due to unprecedented environmental deterioration and lack of governance. There are almost no studies in literature that assessed the role of physical and social environmental settings for nurturing the asthma-prone environment in Karachi.

The study area was initially designed in 1960s with a small residential population. The initial planning is disturbing continuously and now it has become a mixture of planned and unplanned slum in many economically significant areas. New shape of the area is having many problems, such as concentration in one area of commercial markets, manufacturing units, educational and recreational units in the same place that enhance traffic volume and abnormal congestions. So overall situation is unpleasant and authorities are losing their ability to implement laws of planning, traffic and environmental setting. Although over 70% of the area of both these towns is designated as residential by the local development authority, but all types of major urban activities are found side by side here, which was the main reason for choosing these two towns. Within residential areas, land use of commercial markets, educational institutions, timber manufacturing and other traffic attractors (mosques, hospitals, wedding halls, community centre) exist. This has happened through gradual transformation of land use over an extended period of time. The residents are less literate regarding their civic responsibilities. Weak implementation of environmental and building by-laws by local authorities have resulted in chaotic land use all over the city.

Concerning air pollution in the study area, industrial units and automobile exhaust are two main sources. Many environmental toxic chemicals are released in the air by industries. Growing number of vehicles use lead-laced gasoline, poor model of vehicles, poor maintenance of vehicles, use of defective silencers, poor road conditions, rash driving, etc. are the major causes of high concentration of air pollutants in the environment of this area. There is a growing need to formulate proper regulatory laws to limit emission of gaseous pollutant from individual vehicles and implemented forcefully by on-spot checking. Traffic geometry also plays an important role. With time, the vehicles on the roads and the transport routes have become dense and congested producing pollution. Faulty and worn out vehicles should be removed from the roads.

The other reasons of high concentration of air pollutants on the streets are poor model of vehicles, poor maintenance, narrow roads and uneven road surfaces, rash driving, poor education of vehicle drivers, especially commercial vehicle drivers, poor geometrics, frequent traffic jams and congestion aggravated the situation. During traffic jams or signal light the air pollutants, including carbon monoxide concentration, shoots up abruptly within frictions of a minute and becoming a health hazard for human beings. The concentration of air pollutants at a place varies with traffic density and type and condition of vehicles in the given traffic stream. Social and cultural factors also play an important role, like during the festive Eid occasion more people come to the markets, and in summer vacations, students are free to play long hours and that also creates congestion and traffic flow. Seasonal changes in weather conditions higher the wind velocity and more open area around the location lower the concentration of pollutants and several other harmful noxious wastes that results respiratory diseases.

Constant exposure to high-level air pollutants may result in a variety of adverse effects on roadside traders and workers. The reasons of high air pollutants and other gaseous pollutants in ambient air are lack of regulatory laws to gaseous pollutants in the ambient air on the roads. Indoor air quality is also affected by the expansion of industrial units, construction of buildings, utility lines, roads, and housing. Most of the slum areas are in the periphery of the study area with high level of population density and low level of standard of living. Lack of clean environment and medical facilities for the poor population results in asthma and other respiratory.

Vol. 70, No. 4, April 2020

wood panels, wood blocks, ladders and other commercial products, were located openly at the roadside affecting the local population and passers-by (Figure-7A-B). The workers do not care about the wood dust and chemical fumes generated from woodworking and inhale them continuously, without any precautionary measures. Furthermore, due to the temporally extended road construction activities by City District Government of Karachi (CDGK), asthma-prone areas are facing heavy concentration of dust due to heavy vehicle movements and noxious air pollutants (Figure-7C-D). Open drains carrying industrial waste passing through the commercial areas and the residential neighbourhoods provided intimidating environmental conditions that are ideal for the prevalence and dispersion of asthma (Figure-7E-F). Whereas the crowded markets, busy stops, congested roads and overall congestion in the area are also the root causes of the dispersion of respiratory diseases like asthma (Figure-7G-H).
There is a need of a proper policy to cope with this situation which may reduce future respiratory patients.

Policy development will need to cover all important aspects of public health system, from developing and strengthening public health infrastructure like surveillance systems, developing national agenda for asthma and pollution research, access to health care issues, generating local capacity to handle environmental and healthcare issues, and improving at local, provincial and national levels. Implementing these recommendations will require involvement of many stakeholders and could only succeed if properly coordinated at the federal, provincial, and local community level, and within and outside the healthcare delivery system.

Conclusion

In a developing country, like Pakistan, data about diseases and their environmental causes is difficult to collect. Spatial technologies such as high-resolution remote sensing, GIS and other allied tools, could provide not only relatively accurate information but also data management and analysis platform with precise locational accuracy. Further, it was evident that an integrated computing platform, at larger scales, could effectively be used to monitor the menace of respiratory diseases like asthma.

Disclaimer: The datasets generated and/or analysed during the study are not publicly available due to ongoing research, but are available from the corresponding author on reasonable request.

Conflict of Interest: None.

Source of Funding: None.

References


2. Carroll K. Socioeconomic status, race/ethnicity and asthma in youth 2013, pp 1180-1.


28. Dell SD, Jerrett M, Beckerman B, Brook JR, Foty RG, Gilbert NL, et al. Presence of other allergic disease modifies the effect of early childhood traffic-related air pollution exposure on asthma


42. Sarpong SB, Hamilton RG, Eggleston PA, Adkinson Jr NF. Socioeconomic status and race as risk factors for cockroach allergen exposure and sensitization in children with asthma. J Allergy and Clinical Immunology. 1996 Jun;1;97(6):1393-401.


Belanger K, Holford TR, Gent JF, Hill ME, Kezik JM, Leaderer BP. Household levels of nitrogen dioxide and pediatric asthma severity. Epidemiology 2013;24:320.


156. Karim Z, Qureshi BA, Mumtaz M. Geochemical baseline determination and pollution assessment of heavy metals in urban soils of Karachi, Pakistan. Ecol Indicators. 2015;48:358-64.


