Geospatial Modeling of Asthma Population in Relation to Air Pollution
A Decision Support for Health Administration

KETHIREDDY, Swatantra R.¹, TCHOUNWOU, Paul B.², YOUNG, John H.³, LUVALL, Jeffrey C.⁴, AL-HAMDAN, Mohammad.⁵

¹Environmental Science PhD Program, Jackson State University, 1400 J R Lynch St, Jackson, MS 39217. ²Molecular Toxicology Research Laboratory, Jackson State University, 1400 J R Lynch St, Jackson, MS 39217. ³Trent Lott Geospatial and Visualization Research Center, Jackson State University, 1230 Raymond Rd, Jackson, MS 39204. ⁴Global Hydrology and Climate Center, NASA-Marshall Space Flight Center, 320 Sparkman Dr, Huntsville, AL 35805. ⁵Universities Space Research Association, National Space Science and Technology Center, NASA Marshall Space Flight Center, 320 Sparkman Dr, Huntsville, AL 35805

Abstract

Current observations indicate that asthma is growing every year in the United States, for specific reasons for this are not well understood. This study stems from an ongoing research effort to investigate the spatio-temporal behavior of asthma and its relationship to air pollution. The association between environmental variables such as air quality and asthma related health indicators in Mississippi are investigated using Geographic Information Systems (GIS) tools and applications. Health data concerning asthma obtained from Mississippi Department of Health (MSDH) for a 9-year period of 2003-2011, and data of air pollutant concentrations (PM) from 3000 air quality sensors, are analyzed geospatially to establish the impact of air quality on human health, specifically related to asthma. Disease mapping using geospatial techniques provides valuable insight into the spatial nature of the problem, and association of asthma to air pollution. Adverse patient hospitalization data of Mississippi has been analyzed and mapped using quantitive Choropleth techniques in ArcGIS. Patients have been geocoded to their respective zip codes. Potential air pollutant sources of Interstate highways, industries, and other land use data have been integrated in common geospatial platform to understand their adverse contribution on human health. Existing hospitals and emergency clinics are being injected into analysis to further understand their proximity and easy access to patient locations. At the current level of analysis and understanding, spatial distribution of asthma is observed in the populations of zip code regions in Gulf coast, along the Mississippi River, and in the counties of Northeast Mississippi. It is also found that asthma is prevalent in most of the urban population. This GIS-based project would be useful to make health risk assessment and provide information support to the administrators and decision makers for establishing satellite clinics in future.

Introduction

1. Asthma is an economic and health problem. It’s an expensive disease. CDC estimates the United States $56 billion each year (CDC, 2009).
2. A recent survey revealed that in United States, 6.5 million people are affected by asthma.
3. A GIS-based research conducted by Rob, 2003 has found that there is a good correlation between Asthma and poverty. The poverty rate is high in urban regions.
4. Foody, 2006 has presented that the long term chronic disease as the population aging and significant to plan and provide health care needs to a cluster of disease population. He also said that time and space are important dimensions for health GIS studies.
5. Relationships between Disease and Environmental Factors: A critical review on public health and GIS. Rushton, 2003 concludes that establishing associations between disease rates and exposures to environmental factors is an area of increased interest in GIS and spatial analysis/health data.
6. Al-Hamdan et al., 2009 has estimated daily PM2.5 levels combining both Moderate Resolution Imaging Spectroradiometer (MODIS) data and Environmental Protection Agency (EPA) ground data.

Main objectives for this research were, (1) Identify the Asthma disease spatial cluster, (2) Geocoded to Zip dyCode Boundaries Data Integration and Analysis Geocoded to Sreet lines PM2.5 Ground data Quantitative Choropleth Mapping of Diseased Population Kriing Technique Understand the spatio-temporal nature of disease and its relation to air pollution. Healthcare: Identify underserved or over served population. Spatio-temporal pattern of Pollution Methods

Asthma Patient Hospitalisation Data
Hospital Network Data and Number of Patient Beds

Geocoded to Zip dyCode Boundaries

Data Integration and Analysis

Geocoded to Sreet lines

PM2.5 Ground data

Quantitative Choropleth Mapping of Diseased Population

Kriing Technique

Study Region: Mississippi

Project Partners

Mississippi State Department of Health

Observations and Results

Conclusions

At any point of a year between 2003-2011, zip code regions of Jackson urban area have at least 500 to 700 asthma related hospital admissions, and this is the highest rate when compared to rest of state. Along with increase in population count, the spatial area of asthma is also increased in state over the years and can be inferred from above data.

Asthma is observed in the population of Zip code regions in Gulf coast, along the Mississippi River, and in counties of Northeast Mississippi. It is also found that asthma is prevalent in most of the urban population. This GIS-based project would be useful to make health risk assessment and provide information support to the administrators and decision makers for establishing satellite clinics in future.

Future Work

1. Identify seasonal patterns in pollution and hospital admissions.
2. Establish a quantitative relationship between PM2.5 and Asthma related Hospitalizations.
3. Find the underserved and over served clusters of diseased population.
4. Use remotely sensed data (MODIS-AOD) to fill the gaps between ground monitors, and estimate the accurate levels of pollutant over study region.
5. Relationships between Disease and Environmental Factors: A critical review on public health and GIS. Rushton, 2003 concludes that establishing relationships between disease rates and exposures to environmental factors is an area of increased interest in GIS and spatial analysis/health data.

References

1. Asthma’s impact on the nation, data from CDC national Asthma control program.

Acknowledgements

Authors sincerely thank and acknowledge the support of Dr. Lei Zhang, Director of Health Data and Analysis, Mississippi State Department of Health. Authors would also acknowledge Environmental Science PhD program at Jackson State University and Project Partners.