ASSOCIATION BETWEEN OF AMBIENT AIR POLLUTIONAND ASTHMA PREVALENCEIN DIFFERENT POPULATION GROUPS RESIDING IN EASTERN TEXAS

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Abstract
Air pollution has been associated with the increase in asthma prevalence and a significant health impact in human populations. However, its specific effects on asthma prevalence in different age groups, genders and races are not well understood. Thus, the aim of the present study is to examine the associations between selected air pollutants (annual mean concentrations of $PM_{2.5}$-particulate matter with aerodynamic diameter less than 2.5 micrometers, and surface ozone), and asthma prevalence in different population groups (based on age, gender, and race) residing in eastern part of Texas, USA, in 2010. County-wise asthma hospital discharge datafor different age groups, gender, and raceswere obtained from Texas Asthma Control Program, Office of Surveillance, Evaluation and Research, Texas Department of State Health Services,and environmental data for selected air pollutants were taken from the United States Environmental Protection Agency (US EPA)'s air quality system data mart program. Pearson correlation analyses were conducted to examine the relationships between annual mean concentrations ofpollutants and asthma rates for different age groups, genders, and races, using SPSS software version 21. The study results indicated significant variations in the correlation coefficients between asthma rate and air pollution exposure among different age groups, genders, and races in the residents of East-Texas, USA. Thus, steps should be taken to protect the most affected populations from further environmental exposure to air pollution, and to control, prevent or reduce the health impacts.

***Keywords*:** air pollution; asthma; age; gender; race; Texas, USA

Introduction

Air pollution is one of the most serious environmental threats to urban populations (Cohen et al., 2005). It has been reported to cause adverse health impacts on people of all ages. Exposure to common urban air pollutants has been linked to a wide range of adverse health outcomes including respiratory and cardiovascular diseases, asthma exacerbation, reduced lung function and premature death (U.S. EPA, 2006, 2009). Over the past decade, many epidemiologic studies

have demonstrated positive associations between air pollution and mortality (Levy et al., 2000; Goodman et al., 2004; Pope et al., 2004; Schwartz, 2004; Analitis et al., 2006). But, many questions regarding the effects of airpollution remain unanswered and overall the effects of air pollution have not been fully quantified. Most of the studies of air pollution have used time-series analysis to relate daily asthma rates to daily air pollution levels for short-term associations between air pollution and health. Exposure to common urban air pollutants has been linked to a wide range of adverse health outcomes including respiratory and cardiovascular diseases, asthma exacerbation, reduced lung function and premature death (U.S. EPA, 2006, 2009). The evidence on adverse effects of air pollution on public health has led to more stringent standards for levels of outdoor air pollutants in many countries including USA. Airborne pollutants may influence the symptoms of asthma patients (Delfino *et al., 1996, 1997). Asthma is a burden* on communities, with significant public health and financial consequences. The number of complaints increases day by day due to increasing trend of air pollution.

It is well established that air pollution has been associated with the increase in asthma prevalence and a significant health impact in human populations. However, its specific effects on asthma prevalence in different age groups, genders, and races are not well understood. Thus, the aim of the present study is to examine the associations between selected air pollutants (annual mean concentrations of $PM_{2.5}$-particulate matter with aerodynamic diameter less than 2.5 micrometers, and ground level ozone), and asthma prevalence in different population groups (based on age, gender, and race) residing in eastern part of Texas, USA

Study Area

Eastern part of Texas (shown in Fig. 1) was considered for the spatial distribution analysis of air pollutants ($PM_{2.5}$, and O_3) and asthma discharge rate and their associations. Due to insufficient number of air pollution monitoring stations in the western part of the state, only eastern part was considered for the study. Texas State located in the west-south-central region of the United States. The longitude and latitude of the state are 71°47'25"W to 79°45'54"W and 40°29'40"N to 45°0'42"N respectively.

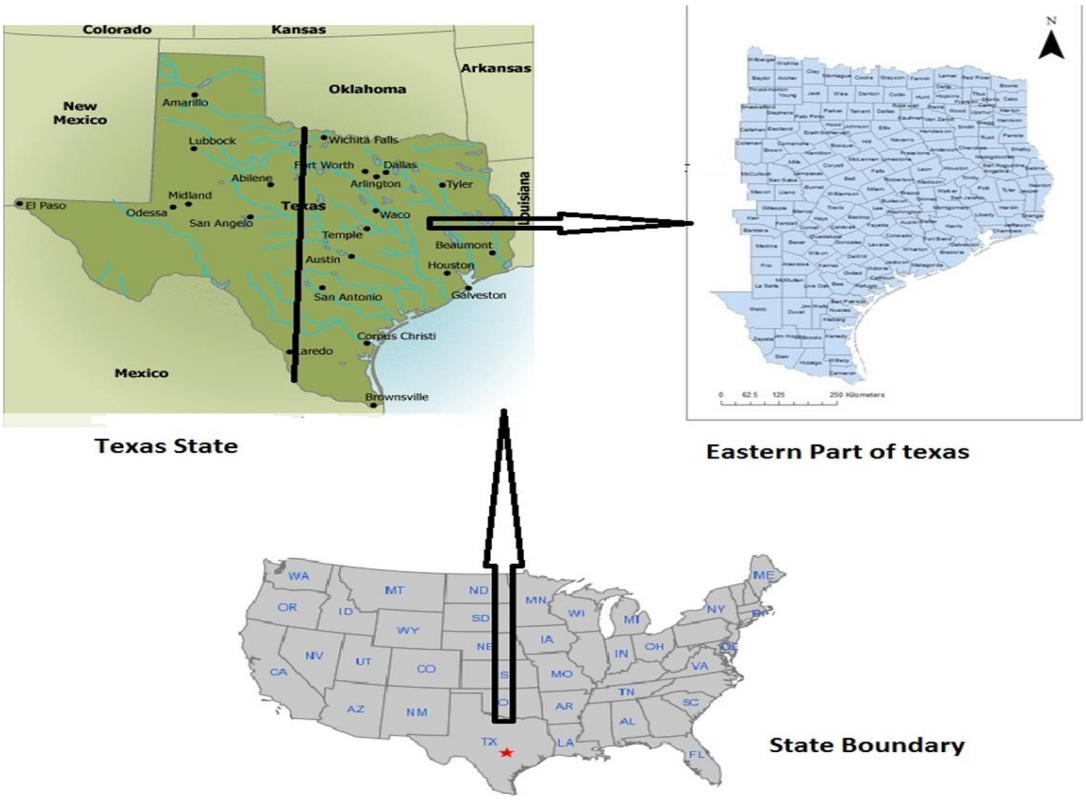

Fig. 1: Study Area Map

Data

Asthma Data

For the year 2010, county-wise asthma hospital discharge numbers and estimated population data were obtained through personal request to Texas Asthma Control Program, Office of Surveillance, Evaluation and Research, Texas Department of State Health Services. The International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code 493 was used to identify asthma hospitalization discharge diagnosis.

Asthma rate indicate the number of asthma-related hospital discharges per 10,000 populations for a specified period of time. The counties reported less than 12 numbers of asthma hospital discharge cases were not reported and thus the asthma rate is assumed to be zero.

Air Pollution Data

Air pollution data collected by U.S. EPA's Air Quality System (AQS) at the various monitoring stations located in different counties of eastern part of Texas for the year 2010 were used for the study. The air pollution data used in this study were taken from the United States Environmental

Protection Agency (U.S. EPA) air quality system data mart (Source: http://www.epa.gov/airdata/ad_rep_mon.html).

The concentrations of two criteria air pollutant parameters ($PM_{2.5}$, and O_3) were considered for the analyses. $PM_{2.5}$ and ozone concentrations were obtained respectively for forty, and fifty nine monitoring stations. The characteristics of the raw data collected from the website are daily average (24 hrs) concentrations of $PM_{2.5}$, daily maximum 8 hours average concentrations of ozone. The daily data for each monitoring station were used for determination of annual average concentrations.

Results and discussion

All point data ($PM_{2.5}$, and O_3) were entered into a Geographic Information System using ArcGIS software from Environmental Systems Research Inc. (ESRI, 2001). The first stage involved determining the location (latitude and longitude) of air pollution monitoring stations given by U.S. EPA monitoring website for the corresponding stations.

The spatial locations of each of the selected monitoring stations along with the pollutant concentrations were fed into the GIS system. Though, there are various types of interpolation techniques (inverse distance weighted method, Kriging, Cokriging, Radial Basis Functions etc.) for spatial mapping, the present study used inverse ordinary kriging method for spatial mapping of air pollution concentrations. The software used for the analysis is Geostatistical Analyst Extension module of ArcGIS version 10.2. In ordinary kriging interpolation method, a smooth surface is estimated from irregularly spaced data points based on the assumptions that the spatial variation in the feature (O_3, and $PM_{2.5}$) is homogeneous over the domain but depends only on the distance between sites. The method interpolates the point data obtained for various monitoring stations in the study area to predict the concentration in each grid cell over a spatial domain. Fig.2(a) and 2(b) depicts the spatial patterns of annual average $PM_{2.5}$ and O_3 concentrations respectively during 2010.

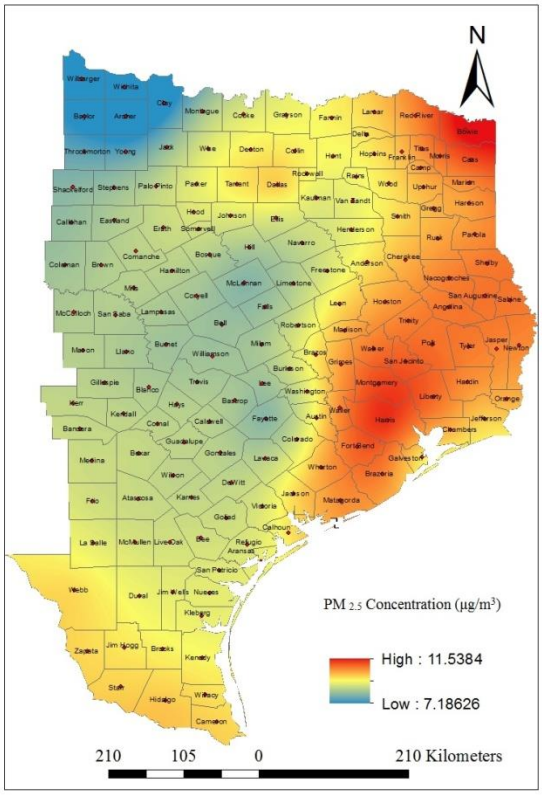

Fig. 2(a): Spatial distribution of $PM_{2.5}$

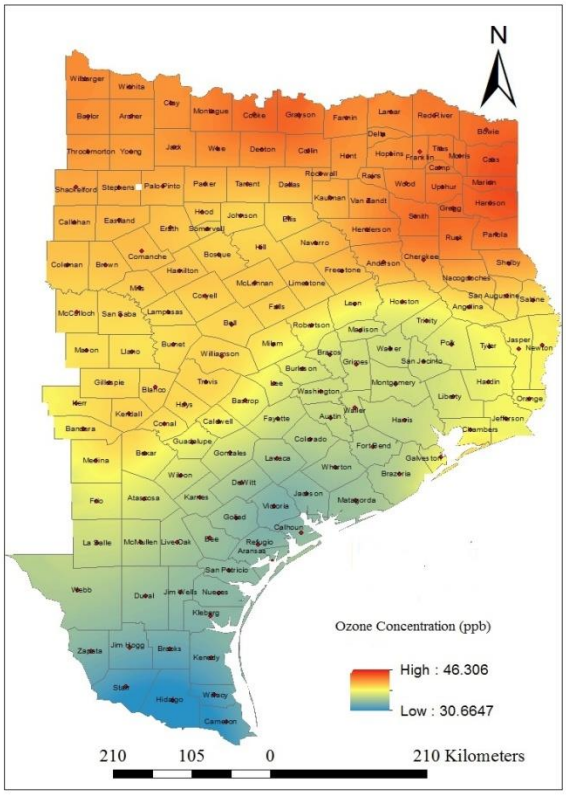

Fig. 2(b): Spatial distribution of O_3

Correlation Analyses

The study sought to investigate the association between air pollution exposure level and asthma cases among different age groups. To understand the inter-relationships among predictor variables, point data correlation analyses were carried out. The extracted point data of $PM_{2.5}$, and O_3 concentrations at the centroid point of each county were compared with the asthma rate with the different population groups for understanding the association. The cross correlation analyses results are presented in Table 1. The results (shown in Table 1) indicate that there is a significant variation in correlation coefficient between air pollutants with different populations groups. Although the results showed positive association between $PM_{2.5}$ and asthma rate in each cases, the correlations were not statistically significant in most of the cases. Ozone levels showed negative correlations with asthma rate in most cases.

Table 1: Correlation Analyses

	Pearson Correlations										
	$PM_{2.5}$	Ozone	AR_All	AR_Black	AR_White	AR_Hispanic	AR_Male	AR_Female	AR_LT 5 Y	AR_5_65 Y	AR_GT 65 Y
$PM_{2.5}$	1										
Ozone	-0.100	1									
AR_All	**0.244****	-0.095	1								
AR_Black	0.148	0.082	0.214**	1							
AR_White	**0.181***	**0.222****	0.733**	0.258**	1						
AR_Hispanic	0.039	-0.003	0.134	0.065	-0.061	1					
AR_Male	0.156	-0.007	0.617**	0.477**	0.562**	0.210**	1				
AR_Female	**0.205****	0.003	0.858**	0.306**	0.767**	0.122	0.655**	1			
AR_LT 5 Y	0.086	-0.037	0.048	0.132	-0.021	0.018	0.149	0.066	1		
AR_5_65 Y	0.111	-0.081	0.399**	0.361**	0.401**	0.038	0.550**	0.497**	0.074	1	
AR_GT 65 Y	0.130	-0.022	0.499**	0.482**	0.529**	0.157*	0.755**	0.624**	0.071	0.461**	1

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

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

Conclusions

The study results indicated significant variations in the correlation coefficients between asthma rate and air pollution exposure among different age groups, genders, and races in the residents of East-Texas, USA. Furthermore, $PM_{2.5}$ is always showing positive effect in triggering the asthma rate, whereas, the association between ozone and asthma rate was not showing a uniform trend. Thus, steps should be taken to protect the most affected populations from further environmental exposure to air pollution, and to control, prevent or reduce the health impacts.

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