ORIGINAL ARTICLE

Relation of air pollution with epidemiology of respiratory diseases in isfahan, Iran from 2005 to 2009

Maasoumeh Rashidi[1], Mohammad Hossein Ramesht[2], Moein Zohary[3], Parinaz Poursafa[4], Roya Kelishadi[5], Zeinab Rashidi[6], Reza Rouzbahani[7]

[1]PhD Student, Department of Geography, University of Isfahan and Remote Sensing Researcher, Iranian Space Research Center, Tehran, [2]Department of Geography, University of Isfahan, [3]Remote Sensing Researcher, University of Tehran and Iranian Space Research Center, Tehran, [4]Environmental Engineering, Environment Research Center, Isfahan University of Medical Sciences, Isfahan, [5]Preventive Pediatric Cardiology, Isfahan Cardiovascular Research Center, Isfahan University of Medical Sciences, Isfahan, [6]Sport Psychology, School of Physical Education, Islamic Azad University, Karaj Branch, Karaj, [7]Specialist in Community Medicine, Researcher, Isfahan University of Medical Sciences, Isfahan, Iran

Background: National Institute of Environmental Health Sciences (NIEHS) scientists shows that long-term exposure to air pollutants increases the risk of respiratory diseases such as allergies, asthma, chronic obstructive pulmonary disease, and lung cancer. Children and the elderly are particularly vulnerable to the health effects of ozone, fine particles, and other airborne toxicants. Air pollution factors are considered as one of the underlying causes of respiratory diseases. This study aimed to determine the association of respiratory diseases documented in medical records and air pollution (Map distribution) of accumulation in Isfahan province, Iran. By plotting the prevalence and spatial distribution maps, important differences from different points can be observed. **Materials and Methods:** The geographic information system (GIS), pollutant standards index (PSI) measurements, and remote Sensing (RS) technology were used after entering data in the mapping information table; spatial distribution was mapped and distribution of Geographical Epidemiology of Respiratory Diseases in Isfahan province (Iran) was determined in this case study from 2005 to 2009. **Results:** Space with tracing the distribution of respiratory diseases was scattered based on the distribution of air pollution in the points is an important part of this type of diseases in Isfahan province where air pollution was more abundant. **Conclusion:** The findings of this study emphasis on the importance of preventing the exposure to air pollution, and to control air pollution product industries, to improve work environmental health, and to increase the health professionals and public knowledge in this regard.

Key words: Air pollution, Iran, Isfahan province, respiratory diseases, spatial distribution

How to cite this article: Rashidi M, Ramesht MH, Zohary M, Poursafa P, Kelishadi R, Rashidi Z, Rouzbahani R. Relation of Air pollution with Epidemiology of Respiratory Diseases in Isfahan, Iran from 2005 to 2009. J Res Med Sci 2013;18:1074-9.

INTRODUCTION

Current scientific evidence, derived largely from studies in North America and Western Europe (NAWE), indicates that urban air pollution, which is derived largely from combustion sources, causes a spectrum of health effects ranging from eye irritation to death. See Table1 for the list of whole effects of air pollution on human health. Recent assessments indicate that the impacts on public health may be considerable. This evidence has increasingly been used by national and international agencies to inform environmental policies, and quantification of the impact of air pollution on public health has gradually become a critical component in policy discussions, such as governments cars restriction for the control of pollution.[1] Sustainable development introduced during the 1980s represents a sure mean to withstand deleterious effects of pollutants observed in most large cities. However, in order to make such concepts effective in urban areas, it is necessary to validate a risk-assessment methodology that can integrate and connect anthropogenic uses of urban areas, air pollution, and the occurrence of some pathologies. One actual and major challenge is how to apprehend complexity of systems due to the interaction of multiple parameters at each level of organization (anthropogenic or biological, individual or population) and scale (regional or local).[2] Such challenges can be facilitated by the development of a multidisciplinary and integrative approach using tools from biology and geography that can allow the analysis of complex systems For example, introducing biomarkers at the cellular and molecular levels in the detection of early biological events induced by pollutants constitutes promising tools in estimating exposure of human population. Respiratory disease is one of the most prevalent diseases in the world and it is expected to be the main cause of death by 2020.[3] Nowadays, the respiratory diseases

Address for correspondence: Maasoumeh Rashidi, PhD Student, Department of Geography, University of Isfahan and Remote Sensing Researcher, Iranian Space Research Center, Tehran, Iran.
E-mail: masoumeh.rashidi@yahoo.com
Received: 15-03-2013; **Revised:** 13-05-2013; **Accepted:** 30-05-2013

are one of the important issues in healthcare. The prevalence of this disease in more countries has been rising as the third leading cause of death and the first group of chronic diseases and concerns the health and treatment in the Iran. New eating habits, increased smoking, increasing air pollution, and the older demographic composition are the predisposing factors in increasing the cases of respiratory diseases. It is estimated that one-third cases of respiratory disease are preventable and a third contingent on early diagnosis are potentially treatable. Scientific advances and progress in many cases of respiratory diseases have been caused to disease containment and control of its causes have provided increase in long-term survival for patients with a wide range of invasive diseases.[3] Despite the lack of attention to air pollution, one of the main reason is the occurrence of respiratory disease.[4] For example, nearly one million tons of Plumb is added to the global soil annually in which large quantities of atmospheric dust, scattering ash, and chemical fertilizers used in agriculture, industry, and urban wastes are included.

MATERIALS AND METHODS

The geographic information system (GIS), Pollutant Standards Index (PSI) measurements, and remote sensing (RS) technology were used after entering data in the mapping information table; we mapped spatial distribution of Geographical Epidemiology of Respiratory Diseases in this case study in Isfahan province (Iran) from 2005 to 2009. In many cases, air pollution factors affecting disease is less under consideration.[5] Isfahan province, with an area of about 107,045 square kilometers, equivalent to 6.3% of the total area of Iran is located between 30° 43′ to 34° 27′ north latitude and 49° 38′ to 55° 32′ east of the Greenwich meridian.[6,7] The province is 1550 m above the sea level altitude. This study aimed at mapping the distribution of respiratory diseases and its relationship with air pollution in this province. In this study we used neural network (NN) to model the trend of air pollution and disease.

Monthly variation in air pollution, simple modeling methods such as linear regression cannot be used in this study. Monthly data of amount of air pollution and number of disease was used to train a multi layer perceptron (MLP) NN. At first step, we used MLP with two hidden layers and 10 neurons in each layer and we train this NN to model and predict the amount of air pollution in future. In order to validate this result, we used air pollution of 2011 [Figures 1-3] and the results show the accuracy of 82% (our NN predicts 105.0891 for 2011 and 105.093 for 2013).

RESULTS

Any visible or invisible particle or gas found in the air that is not part of the original, normal composition; generally any substance that releases into the atmosphere that has damaging effects on living things and the environment is considered air pollution. Carbon dioxide, a greenhouse gas, is the main pollutant that is warming the Earth. Although living things emit carbon dioxide when they breathe, carbon dioxide is widely considered to be a

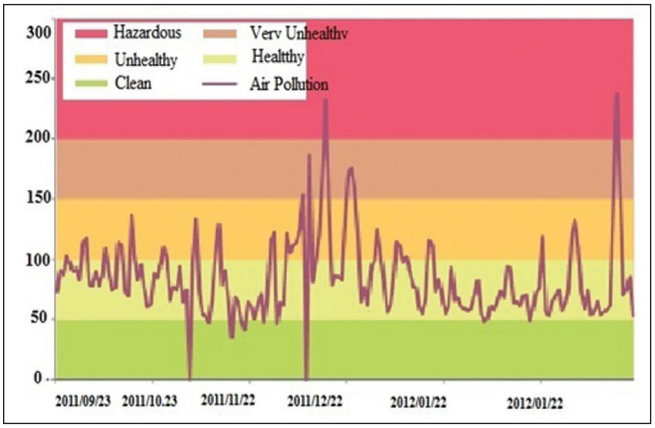

Figure 1: Air pollution in the number of days

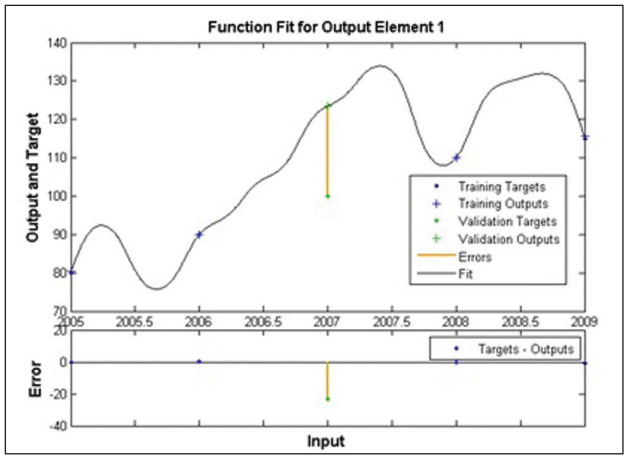

Figure 2: Training result fit for PSI

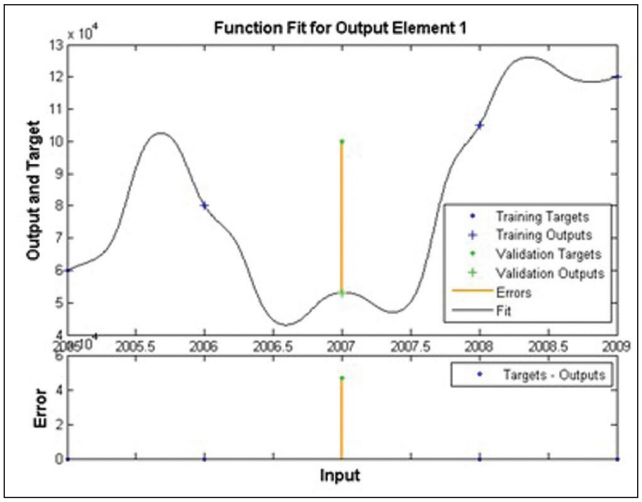

Figure 3: Training result fit for respiratory diseases

pollutant when associated with cars, planes, power plants, and other human activities that involve the burning of fossil fuels such as gasoline and natural gas. In the past 150 years, such activities have pumped enough carbon dioxide into the atmosphere to raise its levels higher than they have been for hundreds of thousands of years. Other greenhouse gases include methane that come from such sources as swamps and gas emitted by livestock and chlorofluorocarbons (CFCs), which were used in refrigerants and aerosol propellants until they were banned because of their deteriorating effect on Earth's ozone layer. Another pollutant associated with climate change is sulfur dioxide, a component of smog.[8] Sulfur dioxide and closely related chemicals not only are known primarily as a cause of acid rain but also reflect light when released in the atmosphere, which keeps sunlight out and causes Earth to cool. Volcanic eruptions can spew massive amounts of sulfur dioxide into the atmosphere, sometimes causing cooling that lasts for years. In fact, volcanoes used to be the main source of atmospheric sulfur dioxide; today, people are the cause.[9] Industrialized countries have worked to reduce levels of sulfur dioxide, smog, and smoke in order to improve people's health. But a result, not predicted until recently, is that the lower sulfur dioxide levels may actually make global warming worse. Just as sulfur dioxide from volcanoes can cool the planet by blocking sunlight, cutting the amount of the compound in the atmosphere lets more sunlight through, warming the Earth. This effect is exaggerated when elevated levels of other greenhouse gases in the atmosphere trap the additional heat.

Major classes of air pollution

- Carbon Oxides (CO and CO_2)
- Sulfur Oxides (SO_2)
- Nitrogen Oxides (NO and NO_2)
- Volatile Organic Compounds (VOCs – CFCs)
- Suspended Particulate Matter (soot, dust, asbestos, lead, etc.).
- Photochemical Oxidants (ozone O3)
- Radioactive Substances (Radon)
- Hazardous Air Pollutants (carcinogens, etc.).[10]

Where do these pollutants come from? [Figure 4]

Air pollution monitoring and measurement

Air pollution can be measured using two methods, which include using PSI data and using RS techniques. PSI date are point data that are more accurate but sparse and they are

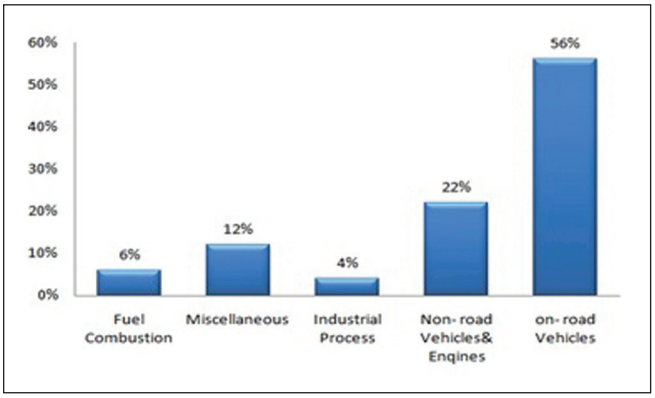

Figure 4: Source of air pollution[11]

Table 1: Effects of air pollution on human health[12]

Health and effects of air pollution	
Pollutant	**Health effects**
Ozone (O3)	Decreases lung function and causes respiratory symptoms, such as coughing and shortness of breath; aggravates asthma and other lung diseases leading to increased medication use, hospital admissions, emergency department (ED) visits, and premature mortality.
Particulate matter (PM)	Short-term exposures can aggravate heart or lung diseases leading to symptoms, increased medication use, hospital admissions, ED visits, and premature mortality; long-term exposures can lead to the development of heart or lung disease and premature mortality.
Lead (Pb)	Damages the developing nervous system, resulting in IQ loss and impacts on learning, memory, and behavior in children. Respiratory and renal effects in adults and early effects related to anemia.
Oxides of sulfur (SOx)	Aggravate asthma, leading to wheezing, chest tightness and shortness of breath, increased medication use, hospital admissions, and ED visits; very high levels can cause respiratory symptoms in people without lung disease.
Oxides of nitrogen (NOx)	Aggravate lung diseases leading to respiratory symptoms, hospital admissions, and ED visits; increase susceptibility to respiratory infection.
Carbon monoxide (CO)	Reduces the amount of oxygen reaching the body's organs and tissues; aggravates heart disease, resulting in chest pain and other symptoms leading to hospital admissions and ED visits.
Ammonia (NH3)	Contributes to particle formation with associated health effects.
Volatile organic compounds (VOCs)	Some are toxic air pollutants that cause cancer and other serious health problems. Contribute to ozone formation with associated health effects.
Mercury (Hg)	Causes liver, kidney, and brain damage and neurological and developmental damage.
Other toxic air pollutants	Cause cancer; immune system damage; and neurological, reproductive, developmental, respiratory, and other health problems. Some toxic air pollutants contribute to ozone and particle pollution with associated health effects.

only available in cities, in contrast, RS provide a continuous and high resolution data.[13]

Aerosol RS relies on measuring the effect of aerosol on solar radiance [Figure 5]. Development in satellite RS and techniques made it possible to measure spatial distribution of deleterious pollutions and the processes affecting them.

The main drawback of satellite measurements is its low spatial resolution. This restricts its application in urban areas but still effective in regional studies. There are many active satellites measuring environmental pollutions, and international space agencies are planning to add an estimated 80 earth-observing missions in the next 15 years.[14] Table 2 describe main satellites and their characteristics.

Other studies compared the accuracy of those products.[13] In this study, in order to detect air pollution in urban areas, we used the Moderate-resolution Imaging Spectra radiometers (MODIS) level II aerosol product (MOD04/MYD04) suitable for near-real-time aerosol data assimilation. We used PSI data in order to improve the accuracy and validation of MODIS product.

Cities with higher air pollution

Cities such as Isfahan, Najafabadf, Borkharand Meimeh, Ardestan, and Natanz are population centers and air pollution in these cities, according to survey, is more than the other cities because human activity is higher in these cities. [Figure 6] shows the cities with high pollution in Isfahan province.

Respiratory disease and air pollution

Diseases of the heart or blood vessels, or respiratory disease, and in particular coronary heart disease (harm to the heart resulting from an insufficient supply of oxygenated blood)

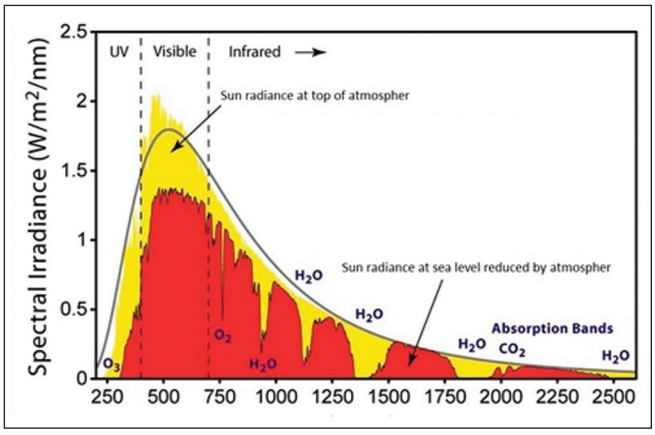

Figure 5: Effect of atmosphere, aerosol, and other particles on solar radiance

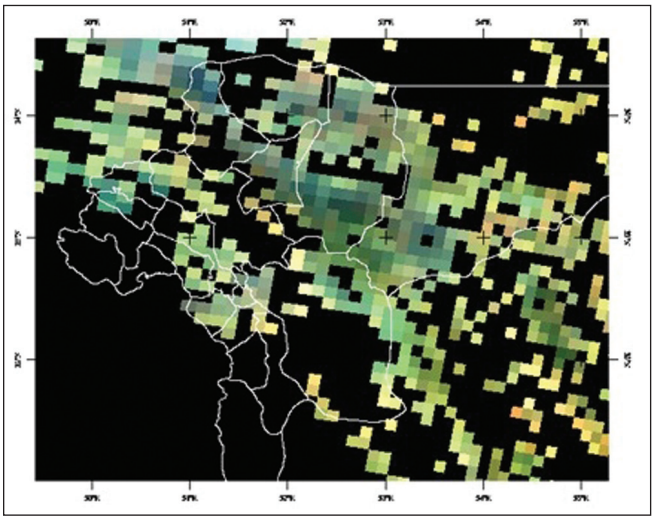

Figure 6: MODIS aerosol product of November 30, 2008

Table 2: Remote sensing instrument comparison chart (NASA)[13,17]

Active sensors for air pollution measurements				
Sensor's name property	**MODIS**	**MISR**	**OMI**	**Parasol**
Global coverage	Daily	8-9 days	Daily	Daily
Swath width	2300 km	380 km	2600 km	2400 km
Overpass time	10:30 Terra 13:30 Aqua	10:30	13:45	13:30
Spectral range	36 bands 0.41-14.38 μm	4 Bands 0.44-0.86 μm	More than 50 bands 0.27-0.50 μm	9 Bands 0.33-0.91 μm
Spatial resolution	0.25 km bands 1-2 0.5 km bands 3-7 1 km all bands	0.275 km Nadir for all angles	13×24 km	6×7 km
Unique sensor capability	Long wavelengths	9 View angles	Ultraviolet wavelenegths	3 Bands polarized 14 View angles
Strengths	Coverage Resolution Calibration Accuracy	Calibration Accuracy Particle shape	Indication of absorbing or scattering particles	Calibration Accuracy Particle shape
Weaknesses	Bright surfaces Ocean glint Nonspherical particles	Coverage	Resolution Cloud contamination	Cloud contamination No coarse aerosol over land

are leading causes of death in Iran.[15] Prevention of these killers has traditionally focused on controlling hypertension, cholesterol levels, and smoking and making healthy choices in regard to diet, exercise, and avoiding second-hand smoke. However, accumulating evidence indicates that air pollutants contribute to serious, even fatal damage to the respiratory system – and air pollution is a factor that you cannot control just through healthy lifestyle. Harmful air pollutants lead to respiratory diseases such as artery blockages leading to heart attacks (arterial occlusion) and death of heart tissue due to oxygen deprivation, leading to permanent heart damage (infarct formation). The mechanisms by which air pollution causes respiratory disease are thought to be the same as those responsible for respiratory disease: pulmonary inflammation and oxidative stress.

DISCUSSION

The population includes 35273 records from respiratory diseases in the province. The time range of this study, according to the number of samples, is sufficiently reliable and over 5 years (over 5 years from 2005 to early 2009 was considered). Impaired synthesis of hemoglobin and anemia, respiratory diseases, malignant disease, hypertension, kidney damage, miscarriages and premature infants, nervous system disorders, brain damage, male infertility, loss of learning, and behavioral disorders in children form the negative effects of high concentrations of the air pollution in the body. Air pollution exists naturally in the environment, but in most cases, the increase in quantity is the result of human activities. There were 19614 men (i.e., 56%) and 15659 women (44%), regarding the mentioned respiratory disease rate, showing more men than women. Analysis rate of respiratory diseases in this case study province shows to be the highest in Isfahan, Najafabad, Borkharand Meimeh, Fereidan, Natanz, Ardestan, Mobarakeh, Lenjanand Naein, respectively, and the lowest rates were in Golpayegan, Tiran and Karvan, Falavarjan and Chadegan, which means that disease rates were higher in central counties of the province. This is observed for the total population. It was significant in most of the central counties of the province. The role of weather pollution in emergence of respiratory diseases in urban communities is considered as an effective factor that could not be modified, such that comforting environmental pollution has been considered relative to different respiratory effects including angina, heart stroke, and heart failures. Respiratory disease is the bitter achievement of advances in technology. The useful role of technology somewhat allows people to have longer life and the harmful role of technology provides the change in life style and immobility.

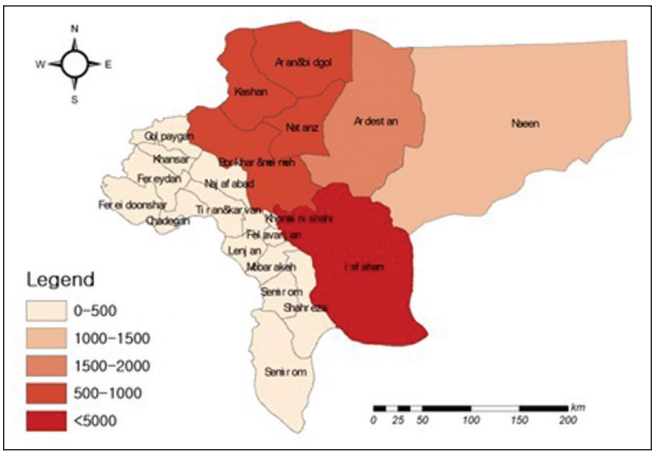

Figure 7: Spatial distribution of Respiratory diseases in case study (Isfahan province, Iran)[16]

CONCLUSION

By drawing the geographical distribution of respiratory diseases [Figure 7] (by the use of GIS software), it was observed that the rate of disease is higher in control and main counties of the province, which could be due to two reasons: (1) Due to existence of air pollution in the main cities of the province including Isfahan, Najafabad, Borkhar, and Meimeh; more vehicle movement in these cities than the other places in the province. (2) Environmental pollutions including the existence of some specific elements and hard urban life all express the verification of the hypothesis. Since the basis for campaign against non epidemic diseases, including respiratory disease is changing people's life style, it seems that it can be achieved by instructions and training people, making required polices and enacting laws and necessary regulations to provide an environment that is suitable for promoting healthy behaviors in life. By proper intervention in the society, the effects of risk factors could be totally eliminated or reduced. Even partial changes could be very useful. Prevention is possible by intervening the risk factors in respiratory diseases such as identification of some elements in the environment and finding the place of their distribution, avoiding the use of air pollutants or using them as little as possible, proper use of technology, changing diets, behaviors, physical habits, reducing anxieties and mental stresses, and other environmental diseases.

REFERENCES

1. Azizi F. Epidemiology and control of common diseases in Iran. Vol. 2. Iran: Tehran University Press; 2001.
2. Braunwald E. Approach to the Patient with Cardiovascular Disease. In: Kasper DL, Branwald E, Favci AS, Havser SL, Longo DL, Jameson JL, editors. Harrison's Principles of Internal Medicine. New York: McGraw-Hill; 2005. p. 1301-4.
3. Reddy KS. Cardiovascular Disease in Non-Western Countries. N Engl J Med 2004;350:2438-40.

4. Nagavi M. The pattern of mortality within 23 provinces of Iran in 2003. Tehran: Health Deputy Iranian Ministry of Health; 2005.
5. Rezaeian M, Dunn G, St Leger S, Appleby L. Geographical epidemiology, spatial analysis and geographical information systems: A multidisciplinary glossary. J Epidemiol Community Health; 2007;61:98-102.
6. Rezaeian M, Dunn G, St Leger S, Appleby L. The production and interpretation of disease maps: A methodological case study. Soc Psychiatry Psychiatr Epidemiol 2004;39:947-54.
7. Rezaeian M. An introduction to the practical methods for mapping the geographical morbidity and mortality rates. Tollo-e-behdasht 2004;2:41-51.
8. Samet JM, Zeger SL, Kelsall J, Xu J, Kalkstein L. "Air Pollution, Weathera nd Mortalityi n Philadelphia,"in ParticulateA ir Pollution and Daily Mortality: Analyses of the Effects of Weather and Multiple Air Pollutants, The Phase IB report of the Particle Epidemiology Evaluation Project, Cambridge, MA: Health Effects Institute; 1997.
9. Schwartz J. Air Pollution and Daily Mortality: A Review and Meta Analysis. Environ Res 1994;64:36-52.
10. Zeger SL, Dominici F, Samet J. Harvesting-Resistant Estimates of Pollution Effects on Mortality. Epidemiology 1999;10:171-5.
11. Research Centre for Atmospheric Chemistry, Ozone and Air Pollution in Isfahan province, yearly reports 2005-2009.
12. WHO (2007). Health risks of heavy metals from long-range transboundary air pollution. Copenhagen: World Health Organization Regional Office for Europe; 2007.
13. Martin RV. Satellite remote sensing of surface air quality. Atmos Environ 2008;42:7823-43.
14. Bréon FM, Vermeulen A, An evaluation of satellite aerosol products against sunphotometer measurements. Remote Sens Environ 2011;115:3102-11.
15. Rashidi M, Ramehsat MH, Ghias M. Geographical epidemiology of death due to Cardiovascular Diseases in Isfahan Province. Vol. 29, No 125. Iran: Journal of Isfahan Medical School; 2011.
16. Isfahan Health Center, Center for death Statistics, yearly reports 2005 to 2009.
17. Beck LR, Lobitz BM, Wood BL. Remote sensing and human health: New sensors and new opportunities. Emerge Infect Dies 2000;6:217-27.

Source of Support: This paper was derived from a specialty thesis at the Department of Geography Sciences, Isfahan University, Isfahan, Iran, **Conflict of Interest:** None declared.