IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 6 Ver. I (June. 2016), PP 105-110
www.iosrjournals.org

An Estimation of COPD Cases Related to Ground-Level Ozone in Tehran, Shiraz And Bandar Abbascities, Iran, During April 2014 to March 2015

Mohsen Heidari[1], Majid Kermani[2], Kavoos Dindarloo[3], Leila Rasuli[4,*]

[1]*assistant Professor, Department Of Public Health, Social Determinants For Health Promotion Research Center, Hormozgan University Of Medical Sciences, Bandar Abbas, Iran*
[2]*assistant Professor, Department Of Environmental Health Engineering, Iran University Of Medical Sciences, Tehran, Iran*
[3]*assistant Professor, Department Of Environmental Health Engineering, Social Determinants For Health Promotion Research Center, Hormozgan University Of Medical Sciences, Bandar Abbas, Iran*
[4]*msc Student Of Environmental Health Engineering, Department Of Environmental Health Engineering, Hormozgan University Of Medical Sciences, Bandar Abbas, Iran*

Introduction:*Ground-level ozone is a pollutant that enters the body mainly by inhalation. Exposure to this pollutant may causerespiratory problems such as inflammation of lung tissue, reduced lung capacity, asthma and nasal congestion. In this study, the excess number of hospital admission for COPD due to ozone exposure was quantified in Tehran, Shiraz and Bandar Abbas cities during April 2014 to March 2015.*

Materials and methods: *In the present cross-sectional study, the required data were obtained from environmental protection agencies of the cities. The validity of the data was assessed according to World Health Organization (WHO) criteria and the valid data were used for the calculation by theAirQ model.*

Results:*The annual mean 8-hr concentration of ozone in the cities was in the order of Shiraz (131 μg/m^3)> Bandar Abbas (60 μg/m >Tehran (49 μg/m). Considering the population of surveyed cities, the excess number of hospital admission for COPD attributed to ozone was in the order of Tehran (209 cases)>Shiraz(125 cases)>Bandar Abbas(50 cases).*

Conclusions:*AirQ model is a useful to estimate the impact of exposure to specific atmospheric pollutants. However, it required sufficient valid annual data. Therefore, it is necessary that the authorities for air quality monitoring in large and industrial cities, especially Bandar Abbas, supply sufficient advanced equipment's in this field.*

Keywords:*Air*pollution, Ozone, AirQ model, Quantification, Health Effects

I. Introduction

Undoubtedly, air is one of the major factors for the living organisms and the life isn't possible without it. Thus, breathing clean air and paying attention to what is entering the human body through inhalation, is of utmost importance [1]. Air pollution is an important issue raised in relation to human health [2]. The results of studies on health effects of photochemical pollutants [3],traffic-related air pollution [4-6] and criteria air pollutants[7,8] confirmedthe harmful health effects of air pollutants, even at low concentrations. Some factorsthat intensify the air pollution are expansion of facilities and factories, dust storms [9], population growth and etc**[10].** The World Health Organization (WHO) has estimated that annually 800,000 people prematurely die around the world, due to cardiovascular and respiratory diseases, and lung cancer which are caused by air pollution [11]. Most ofthe studies in the field of air pollution have focused on the health effect of particulate matters. However, gaseous criteria pollutants such as nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3) and carbon monoxide (CO) also have adverse effects on human health[12-14]. Ozone is one of the most important pollutants that effects on human health. It is a molecule made of three oxygen atoms linked together in a high-energy compound [15]. Ozone is produced in indoor environments through air cleaners, UV lamps, photocopiers and laser printers. This compound is a secondary air pollutant which isproduced through the reactions between primary pollutants (nitric oxides, sulfur oxides, carbon oxides and hydrocarbons), and sunlight [16]. Thispollutant may cause respiratory problems such as inflammation of lung tissue, reduced lung capacity, asthma, nasal congestion and other symptoms such as a burning sensation in the eyes and decreased immunity against infectious diseases [17]. There are several models, mainly based on statistical/epidemiological measures, for the assessment of health effects of air pollutants. The statistical/epidemiological models integrate the air quality data at concentration intervals with epidemiological parameters such as relative risk, baseline frequency and attributable proportion for the quantification of mortality and morbidity due to exposure to the air pollutants[18]. Air Q 2.2.3 Software is one of the most reliable models for the quantification of the potential short-term effects of air pollution on human health [19-20]. Several studies have been conducted to evaluate the mortality and morbidity associated with the criteria pollutants in Iran and other countries[21-23]. Tehran (the capital of Iran, located at 35° 41' N - 51° 25' E), Shiraz (Center of Fars province located in south west of Iran 29°36′ N-52°32′ E) and Bandar Abbas (center of Hormozgan province located in the southern Iran and the north of Persian Gulf 25°24 'N-53°41'E), are some of the major industrial cities of Iran, which have been dealing with air pollution during the past years due to population growth, increased vehicles (Traffic) and industrialization. Given that one of the most important strategies for air pollution control in large cities is the integrated management plans [11-24], any management decision for the control of air pollution in megacities should be made on reliable information about the status of air quality [25,26].Since Shiraz and Bandar Abbas are tropical cities and a massive amount of pollutants is emitted in Tehran, the largest urban area of Iran, it seems the concentration of ground-level ozone would be high in these cities andthe health effects associated with this pollutant should be assessed. In this study, the excess number of hospital admissions for chronic obstructive pulmonary disease (COPD) attributed to O3 pollutant has been studied in Tehran, Shiraz and Bandar Abbas during April 2014 to March 2015

II. Materials and Methods

AiQ2.2.3 model was used to estimate the number of chronic obstructive pulmonary disease (COPD) attributed to O3 pollution in the cities of Tehran, Shiraz and Bandar Abbas. Initially, the hourly data for O3 concentration, which measured during April 2014 to March 2015, were obtained from the Environmental Protection Agencies of each city. In order to do statistical analysis and use the raw data, the validity of the data was examined based on the criteria listed by WHO.Onecriterion is that the ratio between the number of valid data for two seasons (warm and cold) should not exceed 2. To achieve hourly mean concentration out of the data with a shorter averaging time, at least 75% of valid data should be available. To access the 8-hr moving mean values from one-hour values, at least 75 percent (at least 18 hours) of valid hourly average concentration data should be available. Then,some primary actions such as deletion of outlier data and the time adjustment for calculating average data weredone in Excel. The initial unit of O3 concentration data was as ppm (parts per million), while the required unit of the model is mass to volume (μg/m^3). The volumetric unit was converted to gravimetric unit by the following equation;

Eq. 1 $C\left(\frac{\mu g}{m3}\right) = \frac{C(ppm)\times P\times MW}{RT} \times 1000$

where C is gas concentration, P is gas pressure, MW is molecular weight, R is universal gas constant, and T is absolute temperature.

Health Impact Assessment (HIA) using AirQ needs to data of ozone concentration at Standard-Temperature-Pressure (STP) condition (1 atm and 273 °K). The ozone concentration data for non-standard conditions were corrected using the following equation:

Eq. 2 $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

whereP1, T1 and V1 are the pressure, absolute temperature and volume of one mole of gas, respectively, at non-standard conditions and P2, T2 and V2 are the pressure, absolute temperature and volume of one mole of gas, respectively, at STP condition.

In the next stage, the data were further processed (code writing, averaging, and amending the condition). Thereafter, the required statistical indicators including the annual mean, the seasonal meanfor warm and cold seasons, 98thpercentile, and the annual and seasonal maximum 8-hrconcentrations were extracted.

The data for the population, which were taken from the Statistical Center of Iran; relative risk;and baseline frequency of the health effect were entered into AirQ2.2.3 software to estimate the number of cases of COPD attributable to O3 exposure. Note that the relative risk and baseline frequency parameters and the attributable proportion are different for different pollutants. It is worth mentioning that the AirQ is one of the best methods to quantify the effects of pollutants on the basis of "risk assessment"; it is mostly an epidemiological statistics and is presented in 2004 by the BOON Bureau of the European Centre for Environment and Health and WHO. This model being a valid and reliable tool forpredicting short-term effects of air pollutants and enables the user to evaluate the potential effects of human exposure to an identified contaminant in a specific urban area and during a specific time [27,28].

III. Results

The data validation process revealed that the number of stations whose data were considered valid for the analysis were 11 and 1 for Tehran and Shiraz, respectively. It should be noted that, in the case of Bandar Abbas, just the concentration data for warm seasons (i.e. spring and summer) were available. The data for cold seasons (i.e autumn and winter) hadn't been recorded by the Bandar Abbas Environmental Protection Agency due to the administrative and technical constraints.To the best of our knowledge, no study has been conducted on the health effects of criteria air pollutants in this city. Therefore, we attempted to carry out the research

evenwith the limited information. Then the number of hospital admissions for COPD attributed to O_3 exposure was calculated in the city, in the hope that the relevant authorities would set up the appropriate equipment's and record the detailed information about the criteria pollutants in this metropolis.
Table 1 shows the summary of the statistics of ozone concentration data in Tehran, Shiraz and Bandar Abbas. The results show that annual mean 8-hr concentration of O3 in Tehran, Shiraz and Bandar Abbas were 0.49, 1.31 and 0.60 times the national standard and WHO guideline (100 μg/m^3).

Table 1: Summary of ozone concentration in Tehran, Shiraz and Bandar Abbas (April 2014 to March2015)

Ozone concentration (μg/m^3)		Tehran	Shiraz	Bandar Abbas
Annual mean, 8 hr		49	131	60*
Seasonal mean, 8 hr	Cold	36	17	-
	Warm	62	250	60
98th percentile, 8 hr		79	473	110
Annual maximum, 8 hr		86	588	141
Seasonal maximum, 8 hr	Cold	75	93	-
	Warm	86	588	141

* Data for warm season were allocated for throughout the year
Table 2 presents the values of relative riskandbaseline frequency used to estimate hospital admissions for COPD attributable to ozone exposure in the cities.

Table 2: Relative risk with 95% confidence interval (95% CI) and baseline frequency due to ozone exposure

Health effect	Baseline frequency	RR (95% CI) per 10 μg/ m^3
Hospital admission for COPD due to O3 exposure	101.4	1.0058 (1.0022-1.0094)

Finally, the attributable proportion and number of excess cases for COPD due to O3 exposure in Tehran, Shiraz and Bandar Abbas were quantified by AirQ model based on the abovementioned data (table 3).

Table 3: Estimated attributable proportion (AP) expressed as percentage and number of excesscasesin hospital admission for COPD in a year due to exposure to>10 μg/ m^3O_3

	Indicator estimate	Tehran	Shiraz	Bandar Abbas
Estimated attributable proportion (%)	Lower	0.8525	2.7342	1.1179
	Average	2.2165	6.8998	2.8943
	Upper	3.5435	10.7231	4.6080
Estimated number of excess cases (persons/year)	Lower	80.5	49.4	19.2
	Average	209.4	124.6	49.7
	Upper	334.8	193.7	79.1

One of the outputs of the AirQ model is a graph in which the cumulative number of casesisplottedin some concentration intervals for each health effects attributed to the pollutant (Figures 1-3). The numbers of excess hospital admissions for COPD due to O3 exposure for a concentration interval of 10 μg/m3 are summarized in Table 4.

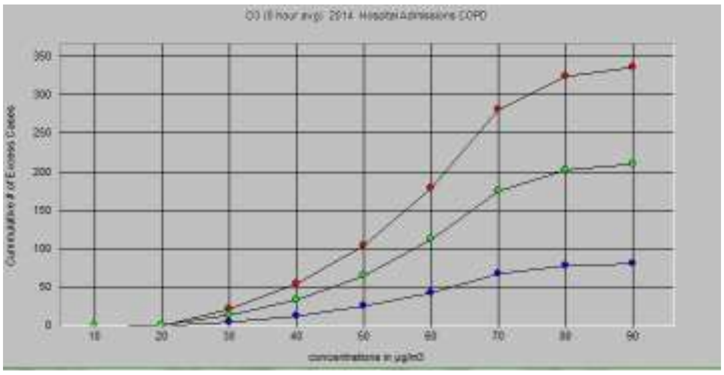

Figure1: Estimation of cumulative number of cases in hospital admissions for chronic obstructive pulmonary disease (COPD) Attributable to ozone exposure (Tehran, Iran, April 2014 to March 2015) (Red with relative risk 1.0094, Green with relative risk 1.0058, Bluewith relative risk 1.2200)

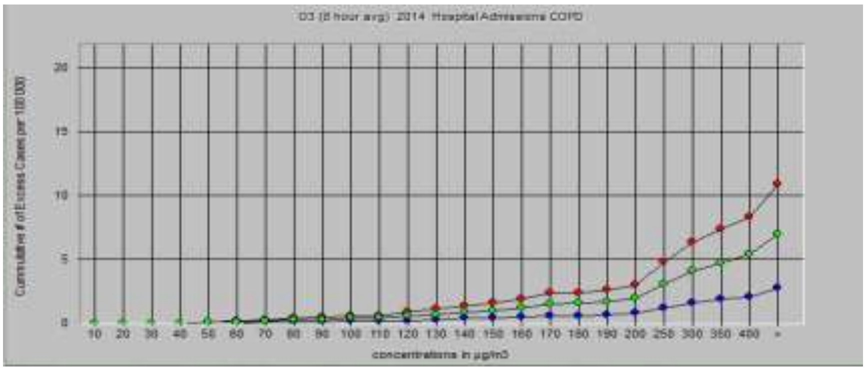

Figure2:Estimation of cumulative number of cases in hospital admissions for chronic obstructive pulmonary disease (COPD) Attributable to ozone exposure (Shiraz, Iran, April 2014 to March 2015) (Red with relative risk 1.0094, Green with relative risk 1.0058, Bluewith relative risk 1.2200)

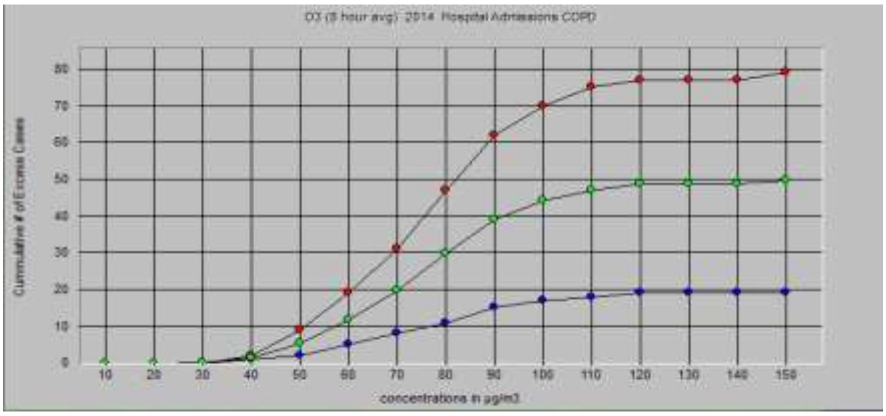

Figure 3: Estimation of cumulative number of cases in hospital admissions for chronic obstructive pulmonary disease (COPD) Attributable to ozone exposure (Bandar Abbas, Iran, April 2014 to March 2015)(Red with relative risk 1.0094, Green with relative risk 1.0058, Blue with relative risk 1.2200)

Table 4: Number of excess hospital admissions for COPD due to O3 exposure in Tehran, Shiraz and Bandar Abbas

concentration for O_3 ($\mu g/m^3$)	Tehran (excess cases)	Shiraz (excess cases)	Bandar Abbas (excess cases)
<10	0.0	0.0	0.0
10-19	0.3	0.0	0.0
20-29	13.4	0.1	0.1
30-39	20.2	0.3	1.3
40-49	31.3	0.6	4.0
50-59	46.9	0.9	6.2
60-69	63.0	1.8	8.0
70-79	27.7	1.1	10.0
80-89	6.6	0.9	9.2
90-99	0.0	1.1	5.2
100-109	0.0	0.4	2.9
110-119	0.0	3.1	1.6
120-129	0.0	2.9	0.0
130-139	0.0	3.1	0.0
140-149	0.0	2.3	1.0
150-159	0.0	3.6	0.0
160-169	0.0	5.2	0.0
170-179	0.0	0.7	0.0
180-189	0.0	2.2	0.0
190-199	0.0	4.6	0.0
200-249	0.0	20.6	0.0
250-299	0.0	17.8	0.0
300-349	0.0	11.2	0.0
350-399	0.0	11.2	0.0
>400	0.0	29.0	0.0

IV. Discussion

According to Table 1, we can say that in Tehran and Shiraz, the mean concentration of ozone in warm seasons was higher than that of cold seasons. The annual mean 8-hr concentration of ozone in Tehran, Shiraz and Bandar Abbas were 49, 131 and 60 micrograms per cubic meter, respectively. Therefore, among the cities, the annual mean 8-hr concentration of O3 was highest in Shiraz. Gudarzi et al (2014) reported that the mean annual concentration of ozone in Shiraz was more than that of Mashhad, Tabriz, Isfahan and Arak [19]. As depicted in table 1, the annual mean 8 hr concentration of ozone in Shiraz was higher than the national standard and WHO guideline (100 μg/m3), while the values for two other cities were lower than the regulatory limit. To find the reasons for higher level of O3 concentration in Shiraz, it is recommended to attend the ozone precursors, the impact of weather conditions, geographical location, etc. Another point that should be noted is the relative risk resulting from O_3 effects on human health which is shown in Table 2. This parameter is written for O_3 concentration of 10 $\mu g/m^3$ at three levels: low (CI = 0.05), mean and high (CI = 0.95). By taking into account the mean relative risk values, the rate of hospital admission for COPD was increased by 0.58%for every increase of 10 $\mu g/m^3$ in ozone concentration. According to figures 1-3 and other results of this study, the highest excess cases of hospital admission for COPD due to O3 exposure in Tehran (63 cases), Shiraz (29 cases) and Bandar Abbas (10 cases) were occurred in concentrations ranges of 60-69 μg/m3, >400 μg/m3, and 70-79 μg/m3, respectively.

Attributable proportion could be calculated with respect to baseline frequency (101.4 cases per 100000 people) and relative risk (1.0058). In this regard, the values of attributable proportion in the cities were in order of Shiraz (6.8998%)>Bandar Abbas (2.8943%)>Tehran (2.2165%). However, by taking into account the population of the cities,the number of excess cases of hospital admission for COPD due to O3 exposure was in the order of Tehran (209.4 persons)>Shiraz (124.6 persons)>Bandar Abbas (49.7 persons). Sanhueza et al examined the relationship between O_3concentration and hospital admissions forrespiratory diseases in America and found that the asthma, COPD in all people, and COPD in people older than 65 years attributable to O3 exposure were 1166, 5625 and 3096 cases, respectively [29].GhanbariQozikeli et al quantified the health effects of exposure to O3 in Tabriz using AirQ model. They reported that the relative risk, proportion percentage and the number of excess cases of hospital admission for COPD attributed to O3 exposure were 1.0058, 2.9893, and 44 persons, respectively[30]. Goudarzi et al (2013) reported the values of 3.52 and 35 persons, respectively, for attributable proportion percentage and number of excess cases of hospital admission for COPD attributed to O3 exposure in Ahvaz, iran. Overall, this study and the previous researches in this field revealed that the pollution of air toozone, a criteria air pollutant, leads to higher rates of COPD.

Despite the low values of relative risk for COPD attributable to O3exposure, the burden of COPD due to O3 exposure in the studied cities was considerable. This is resulted from the huge population of the cities. So the authorities should devote efforts and appropriate measures to control and reduce air pollution in the metropolises through applying using short-term and long-term plans.

V. Conclusions

In this study the health effects of O3 exposure, in view of the burden to COPD, was quantified in Tehran, Shiraz and Bandar from April 2014 to March 2015. The annual mean 8-hr concentration of O3 and relative risk values in the cities was in order of Shiraz>Bandar Abbas>Tehran. However, the number of hospital admission for COPD attributable to O3 was highest in Tehran which is the most populated city of Iran. Although AirQ model and its related recommendations of the World Health Organization is a useful to estimate the impact of exposure to specific atmospheric pollutants, it required availability of sufficient valid annual data. Therefore it is necessary that the authorities for air quality monitoring in large and industrial cities, especially Bandar Abbas, supply sufficient advanced equipment's in this field. Undoubtedly, developing short- and long-term strategies in the field of air pollution control would require reliable information about the current state of air quality in the community.

Acknowledgment

This article is the result of MSc thesis approved in the Hormozgan University of Medical Sciences (HUMS). The authors wish to acknowledge to Vice Chancellery of Research of HUMS for the financial support.

References

[1]. Kermani, M., et al., TSP and PM10 measurement and description of air quality index (AQI) in the ambient air in shariati hospital district. Journal of School of Public Health and Institute of Public Health Research, 2004. 2(1): p. 37-46.

[2]. Samet, J.M., et al., The national morbidity, mortality, and air pollution study. Part II: morbidity and mortality from air pollution in the United States Res Rep Health Eff Inst, 2000. 94(pt 2): p. 5-79.

[3]. Delfino, R.J., M.R. Becklake, and J.A. Hanley, The relationship of urgent hospital admissions for respiratory illnesses to photochemical air pollution levels in Montreal. Environmental Research, 1994. 67(1): p. 1-19.

[4]. Downs, S.H., et al., Reduced exposure to PM10 and attenuated age-related decline in lung function. New England Journal of Medicine, 2007. 357(23): p. 2338-2347.

[5]. Gauderman, W.J., et al., Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. The Lancet, 2007. 369(9561): p. 571-577.
[6]. Jerrett, M., et al., Traffic-related air pollution and asthma onset in children: a prospective cohort study with individual exposure measurement. Environmental health perspectives, 2008. 116(10): p. 1433.
[7]. Miller, K.A., et al., Long-term exposure to air pollution and incidence of cardiovascular events in women. New England Journal of Medicine, 2007. 356(5): p. 447-458.
[8]. Brunekreef, B. and S.T. Holgate, Air pollution and health. The lancet, 2002. 360(9341): p. 1233-1242.
[9]. Geravandi, S., et al., Health effects of exposure to particulate matter less than 10 microns (PM10) in Ahvaz. J Qazvin Univ Med Sci, 2014. 18(5): p. 45-53.
[10]. Asl, F.B., et al., Estimation of Diseases and Mortality Attributed to NO2 pollutant in five metropolises of Iran using AirQ model in 2011-2012.
[11]. Goudarzi, G., et al., estimation of number estimation of number of cardiovascular death, myocardial infarction and chronic obstructive pulmonary disease (copd) from no2 exposure using air q model in ahvaz city during 2009. 2013.
[12]. Katsouyanni, K., et al., Short term effects of ambient sulphur dioxide and particulate matter on mortality in 12 European cities: results from time series data from the APHEA project. Bmj, 1997. 314(7095): p. 1658.
[13]. Schwartz, J., How sensitive is the association between ozone and daily deaths to control for temperature? American journal of respiratory and critical care medicine, 2005. 171(6): p. 627-631.
[14]. Castell, N., et al., Real-World Application of New Sensor Technologies for Air Quality Monitoring. 2013, European Topic Centre on Air Pollution and Climate Change Mitigation Bilthoven, The Netherlands.
[15]. Geravandi, S., et al., Estimation of cardiovascular and respiratory deaths related to ozone exposure in Ahvaz, during 2011. Journal of Rafsanjan University of Medical Sciences, 2015. 13(11): p. 1073-1082.
[16]. Sanhueza, P.A., et al., An environmental decision-making tool for evaluating ground-level ozone-related health effects. Journal of the Air & Waste Management Association, 2003. 53(12): p. 1448-1459.
[17]. Ghanbari Ghozikali, M., M. Mosaferi, and K. Nadafi, quantification of the health effects of exposure to ozone in tabriz by using airq model. Urmia Medical Journal, 2014. 25(6): p. 521-530.
[18]. Krzyzanowski, M., A. Cohen, and R. Anderson, Quantification of health effects of exposure to air pollution. Occupational and environmental medicine, 2002. 59(12): p. 791-793.
[19]. Goudarzi, G., et al., Health endpoints caused by PM10 exposure in Ahvaz, Iran. Iranian Journal of health, Safety and environment, 2014. 1(4): p. 159-165.
[20]. Palit, D., et al., Assessment of air quality using several bio monitors of selected sites of Durgapur, Burdwan district by air pollution tolerance index approach. Indian Journal of Scientific Research, 2013. 4(1): p. 149-152.
[21]. Fattore, E., et al., Human health risk in relation to air quality in two municipalities in an industrialized area of Northern Italy. Environmental research, 2011. 111(8): p. 1321-1327.
[22]. Allen, R.W., et al., An assessment of air pollution and its attributable mortality in Ulaanbaatar, Mongolia. Air Quality, Atmosphere & Health, 2013. 6(1): p. 137-150.
[23]. Goudarzi, G., et al., Cardiovascular deaths related to Carbon monoxide Exposure in Ahvaz, Iran. Iranian Journal of health, Safety and environment, 2014. 1(3): p. 126-131.
[24]. Calderón-Garcidueñas, L., et al., Megacities air pollution problems: Mexico City Metropolitan Area critical issues on the central nervous system pediatric impact. Environmental research, 2015. 137: p. 157-169.
[25]. Arfaeinia, H., et al., Comparative Investigation of Health Quality of Air in Tehran, Isfahan and Shiraz Metropolises in 2011-2012. Journal of Health in the Field, 2014. 1(4).
[26]. Toh, Y.Y., S.F. Lim, and R. Von Glasow, The influence of meteorological factors and biomass burning on surface ozone concentrations at Tanah Rata, Malaysia. Atmospheric Environment, 2013. 70: p. 435-446.
[27]. Shakour, A., et al., Health impacts of particulate matter in greater Cairo, Egypt. J Am Sci, 2011. 7(3): p. 840-48.
[28]. Zalaghi, E., Survey of health Effects of Air Pollution Ahvaz, Bushehr and Kermanshah with Use of AIRQ Model. 2010, MSc Thesis, Islamic Azad University, Science and Research Branch, Ahvaz.
[29]. Ghorbanli, M., Z. Bakand, and S. Bakand, Air pollution effects on the activity of antioxidant enzymes in Nerium oleander and Robinia pseudo acacia plants in Tehran. 2007.
[30]. Goudarzi, G., et al., Cardiopulmonary mortalities and chronic obstructive pulmonary disease attributed to ozone air pollution. Archives of Hygiene sciences, 2013. 2(2).