



Available Online through

www.ijptonline.com

THE PREVALENCE OF CARDIOVASCULAR DISEASE AND ITS RELATION WITH WEATHER CONDITION AND AIR POLLUTANTS DURING A PERIOD OF SIX YEARS (2006-2011)- A CASE STUDY, KERMANSHAH, IRAN

Razieh Khamutian^{1,2}, MohamadJavad Shokoozadeh¹, Meghdad Pirsaeheb¹, Kiomars Sharafi^{1,3*}

¹Research Center for Environmental Determinants of Health, Kermanshah University of Medical Sciences, Kermanshah, Iran.

²Department of Environmental Health Engineering, School of Public Health, Hamadan University of Medical Sciences, Hamadan, Iran.

³Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.

Email:kio.sharafi@gmail.com

Received on 12-02-2016

Accepted on 05-03-2016

Abstract

Development, urbanization, industrial activity and increasing fossil fuels leads to air pollution in many parts of the world, followed by rapid growth of cardiovascular disease. Kermanshah city as a metropolis is no exception of this issue. The purpose of this study was to determine the association between air pollutants and climatic factors referred to the extent of cardiovascular patients in hospital in Kermanshah city. This study is cross-sectional and ecological. In this study, data on the number of cardiovascular patients, the concentration levels of air pollutants and weather conditions were collected from the city of Kermanshah. To determine the association between cardiovascular patients admitted to hospital and air pollutants, poisson regression was used (P value < 0.05). Based on the results of poisson regression among air pollutants and climatic factors including carbon monoxide, particulate matter, temperature, precipitation and pressure were associated with the number of cardiovascular patients referred to hospitals, with relative risk of 1.006, 1.123, 0.989, 0.956 and 1.05, respectively. The results showed the reduction of temperature and increasing of pressure led to increasing the number of cardiovascular patients. Based on the results, there was a significant positive association between air pollutants (mainly carbon monoxide and particulate matter) and the total number of heart patients admitted to hospitals in Kermanshah. However, due to heart diseases are multifactorial, in addition to air pollution other factors have key roles in creating and exacerbating of cardiovascular diseases. The present study confirms previous studies on the adverse effects of air pollution as a risk factor for cardiovascular disease in the community.

Keywords: Air Pollution, Weather Conditions, Cardiovascular Disease

Introduction

The spread of the urbanization and development of the cities with increasing the population and industrial development and use of the fossil fuels caused the air pollution, environmental degradation, ecosystem change and climate fluctuation which affected the humans health directly and indirectly and exacerbated the disease such as lung disease, heart and respiration disease rate and increased mortality (1). Cardiovascular diseases are the main and common cause of death and disability. The statistics showed that the second cause of death (40-50%) in Iran is cardiovascular disease after the traffic accidents (2). There are some risk factors which prone the individuals to affected by coronary artery disease and cardiovascular disease. These factors divided into various categories such as heredity, age, sex, race, hypertension, smoking and environment (3). Among the mentioned factors, the environment and environmental pollutants effect have an important role in this field in a way that the relation between the anthropogenic pollutants level and humans disease have been represented for more than half of a century. Several important environmental events which occurs due to the increased of pollutants level in some industrial city and caused an extensive mortality in this cities have confirmed this fact. Despite the improvement of air quality after several decades, the air pollution and its destructive effects still consider as an important issue for environment and humans and various studies have addressed this issue (4). Many epidemiological studies have been done in relation with air pollutants and mortality rate which is due to the cardiovascular disease and it indicated that, there was a positive and significant relation between pollutants and climate factors with the death rate which was due to the cardiovascular disease (5,6). For example in a review study which evaluated 15 cities in Italy during 1996-2000, it was observed that by increasing the concentration of nitrogen dioxide (NO₂), carbon monoxide (CO), sulfur dioxide (SO₂) and PM₁₀ the death numbers which were due to the cardiovascular disease were increased respectively by the coefficient of 0.4%, 0.93%, 1.11% and 0.54% (Biggeri et al., 2003). In another study which has conducted by Gholizadeh et al. in Tehran (2009), the data which were related to the four years of 2002-2005 were evaluated and among the air pollutants the CO was seleted as an index. This study showed that, there was a significant relation between the correlation coefficient and Co concentration and the numbers of death due to the cardiovascular, respiratory and heart attackts disease and finally the total rate of mortality during the evaluated years were respectively 0.72, 0.70, 0.69, and 0.67 (7). In comparison with other studies in relation with air pollutants level and the rate of the mortality due to the cardiovascular disease, in few studies the relation between air pollutants level and

the numbers of referred cardiovascular patients to hospital have been evaluated which most of these studies were related to European countries (8), North America (9) and Sydney Australia (10).

In a study which have done in Spain, there was a significant relation between the referred cardiovascular patients and SO₂, black smoke and CO concentration in hot season with relative risk (RR) of respectively 1.05, 1.038 and 1.029 (8). In another study which has done in Sydney of Australia, the number of emergency cardiovascular patients of over 65 years old in a 5 years period were evaluated and among the emergency cardiovascular patients and particles, CO and NO₂ there was a positive and significant relation (10). In addition to environmental pollutants, climate elements such as air temperature, humidity and pressure would have effect the incidence rate of cardiovascular disease which in some studies the impact of these factors have considered (11-13). Nowadays in developed countries because of the strict environmental laws during the recent years, the air pollution have been controlled but in developing countries because of the non-structured changes of life style from traditional to industrial and lack of the precise control on the pollutant sources, the air pollution have an growing trend(14).The developing countries include Iran, which based on the World Health Organization (WHO) in 2011 three cities of this country reported as the most polluted cities in the world. The Kermanshah city which has located in the west of Iran is one of them. The main source of pollution in this city include petrochemical industry, paper plants, cement factories, textile and other industrial factories (15). Also the everyday growing of the automobile in this city which were mostly old, and don't have the necessary environmental standard, caused the pollution of this city. In addition to it, in recent years, the ingress of dust which originated from neighborhood countries (Iraq and Saudi-Arabia) exacerbates the air pollution of this city. The studies have showed that the dusts in addition to having suspended particles have polluted gas such as NO₂ and SO₂ (16). Due to the fact that, an epidemiological study in the field of the relation between air pollution and cardiovascular disease have not been done yet in Kermanshah and according to the fact that this city have a particular climatic and cultural property and it is not possible to generalized the results of other studies in this regard with this study, the necessity of doing this research would become evident. The aim of the present study is to determine the relationship between air pollution and the referral rate of cardiovascular patients to the Kermanshah city's hospital.

Material and Methods

• The studied population

The Kermanshah city located in the west of Iran with the latitude of 34 degree and 18 north minute and 47 degree and 4 east minute. Its height from the sea level is 1430 meter and the average, maximum and minimum annual

temperature is respectively 14.2, 38 and 3.2 degree(Figure 1). This city's population with an area of 93.3km² based on the 2010 census is more than 980786 person. This is an ecological-analytical study.in this study the total number emergency cardiovascular patients who referred to the Kermanshah's hospital during the study time (2006-2011) were collected. The cardiovascular disease of this study include the coronary heart disease, peripheral arterial disease, deep vein thrombosis, pulmonary embolism and atherosclerosis. It should be noted that in this study, just the patients who live in Kermanshah have been considered. The data which were related to the air pollutants concentration level that used in this study have been measured online by sampling station and Kermanshah's air analysis of environmental protection. The metrological data which were used in this project have been measured by metrological organization of Kermanshah.

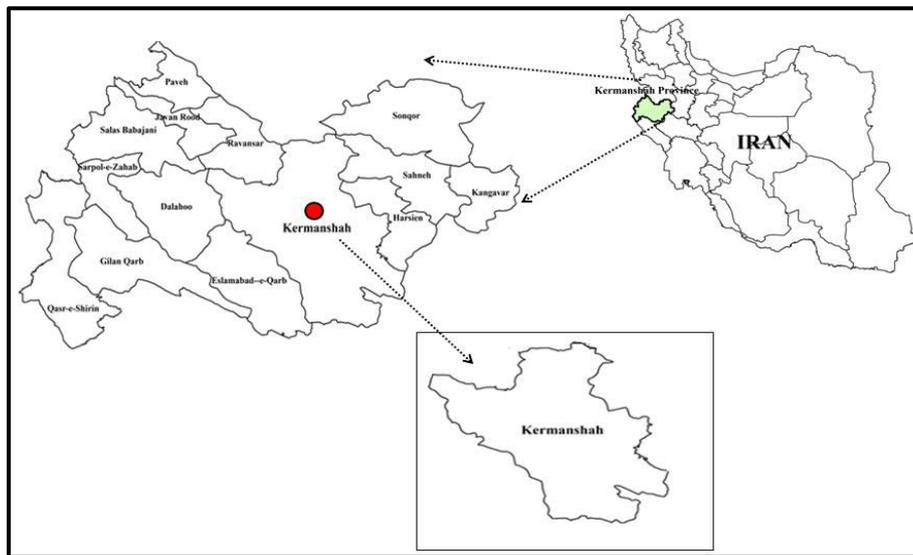


Figure-1. The location map of the Kermanshah city in Iran.

- **The data analysis**

The statistical SPSS.21 software was used for data analysis. For comparing the average number of cardiovascular patients who referred to the hospitals the One Way ANOVA statistical test was used. To determine the relation between the rate of the cardiovascular patients which referred to the Kermanshah's hospital the generalized linear model and Poason regression (P value= 0.05) was used. The generalized linear model was used for quantized data.

Results

In present study, the data of the referred cardiovascular disease were collected from 7 hospital of Kermanshah. According to the obtained data the most number of patients were referred to the Imam Ali hospital in a way that the total average of the referred patients to this hospital was 4106 while the average of the referred patients to other hospital was less than 10 person. Therefore, the Imam Ali hospital was chosen as the reference and standard for this

research. The average frequency of cardiovascular patients who referred to the hospital have been shown in Figure 2

based on the year. The results of the One Way ANOVA statistical test showed that, there was a significant difference among many of the years about the rate of the cardiovascular patients who referred to the hospitals (P value < 0.05).

For showing the differences of the average reference in the evaluated year, the Tukey test which come after the One Way ANOVA test was used in two forms (Table2). The concentration of the air pollutants (in the form of maximum and minimum) was presented in Table 1. The relation between the numbers of the cardiovascular patients who referred to the hospital and the air pollutants variables and climatic factors were evaluated by Poason Regression and generalized linear model log linear and its results have been presented in Table 3 to 4. The average level of the cardiovascular patients who referred to the Kermanshah’s hospital in the (2006-2011) based on the seasons have been presented in Figure 3.

Table-1: The concentration of air pollutants (maximum,mean and minimum). in 2006- 2011.

Parameters	Mean	S.D	Min	Max
O ₃	21.6	15.59	0	158
NO	23.3	18.9	0.17	141.75
NO ₂	23.8	16.8	0.38	107.2
PM ₁₀	133.8	137.7	0	2758.6
SO ₂	23.47	15.3	0.08	156.4
CO	1.75	1.06	0.2	9.08

Table-2: Mean number of patients admitted with cardiovascular disease.

Year	P	Year	P	
2006	2007	2009	2006	<0.001
	2008		2007	<0.001
	2009		2008	0.001
	2010		2010	0.336
	2011		2011	0.999
2007	2006	2010	2006	<0.001
	2008		2007	<0.001
	2009		2008	<0.001
	2010		2009	0.336
	2011		2011	0.652
2008	2006	2011	2006	<0.001
	2007		2007	<0.001
	2009		2008	<0.001
	2010		2009	0.999
	2011		2010	0.652

Table-3: The relationship between air pollutants and climate elements with number of patients admitted with cardiovascular disease.

Parameters	95% Wald Confidence Interval		β (The regression coefficient)
	Lower	Upper	
NO ₂	-0.013	0.001	-0.006
PM ₁₀	0.004	0.007	0.006
CO	0.042	0.019	0.116
O ₃	-0.001	0.008	0.003
SO ₂	-0.003	0.001	-0.001
Temperature	-0.013	-0.008	-0.011
Precipitation	-0.065	-0.024	-0.044
Pressure	-0.039	0.058	0.049
Humidity	-0.003	0.006	0.002

Table-4: The Relative Risk and Confidence Interval investigated parameters.

Parameters	CI (Confidence Interval)		RR (Relative Risk)
PM ₁₀	1.007	1.004	1.006
CO	1.21	1.042	1.123
Temperature	0.99	0.08	0.989
Precipitation	0.976	0.937	0.956
Pressure	1.059	1.039	1.05

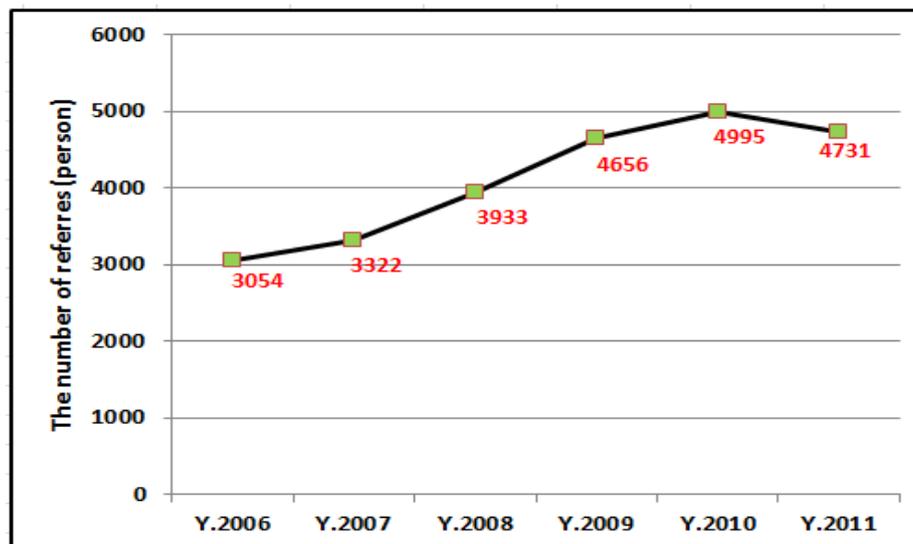


Figure-2. The average frequency of cardiovascular patients who referred to the hospital based on the years (2006-2011)

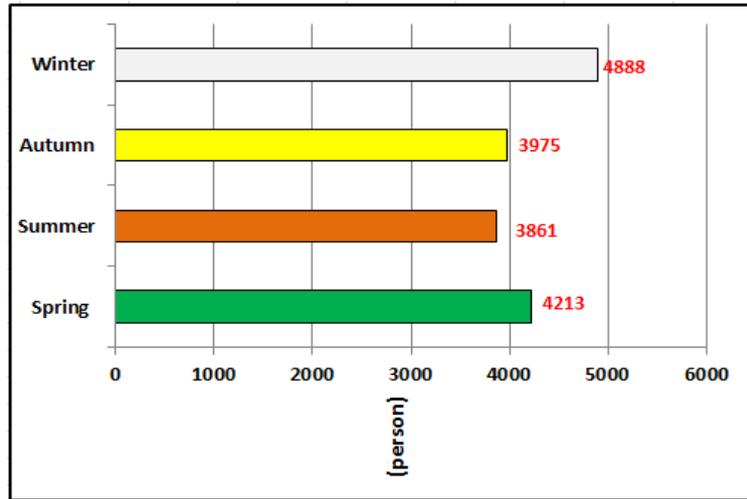


Figure-3.The average frequency of cardiovascular patients who referred to the hospital based on the seasons.

Discussion

The cardiovascular disease are the most common and serious in industrial community and an issue in developing community(17). The results of the present study showed that the Kermanshah city like the other society faced with a growing trend of cardiovascular disease in a way that from 2006-2011 an average of 11% was added to the referred patients. According to the fact that the data of the referred cardiovascular patients of 2006 is related to the first six months of the year, the increasing trend has not been presented. The results of the other studies are consistent with the present study. The results of the studies which have done in the Amsterdam of Netherland (1999) (18) Montreal Canada (2001) (19) and Madrid of Spain (1980-1993) (20) showed that the cardiovascular disease hospitalization and referral is increasing in these countries.

In a study which have conducted in Netherland the number of the referred cardiovascular patients during the 1975 to 1995 was evaluated and it was observed that during this period the number of the referred patients become doubled in comparison with the primary rate of it. In 1975 the cardiovascular patients referral rate constitute 10% of all the hospital which in 1995 this rate become 16% (18).

According to the results of the present study, between the data of the research such as climatic factors (temperature, pressure, precipitation) and air pollutants (CO, particle and the total number of cardiovascular Patients who referred to the hospital of Kermanshah, there was a strict and significant relationship. Wherever the temperature decreased and pressure increased is exist, the number of the cardiovascular patients who referred to the hospital would increase. Based on the findings, the temperature decreased caused the pressure increased and the inversion layer height decreased and increased of the pollutants concentration density in the limited atmosphere (21).

The average of the most referred cardiovascular disease was in April, May and February and based on the season the most referred was estimated in spring and winter. Based on the obtained results from this study, there was a high co-linearity between some variables (climatic elements and air pollutants) which in Poason Regression model the highly correlation of variables were set aside. The results of the table 4 showed that, between CO, Cd and the less than 10 μ m particles and the referred cardiovascular patients there was a positive and significant relation respectively with the relative risk of RR=1.006, confidence interval of 1.004-1.007 and RR= 1.123, confidence interval of 1.042-1.21. The other evaluated pollutants in multi-variable model showed a significant relation with the number of the referred patients to hospitals. The results of the other studies are consistent with the findings of the present study. A study which has conducted in Chicago (1998) showed that CO and the rate of referral to the hospitals due to the congestive heart failures disease in three range of low, average and high temperature respectively with the RR of the 1.05, 1.09 and 1.02 have a positive relation (22). In a study which have done in Canada (2011) among the evaluated pollutants the increase of the PM₁₀ and O₃ have a significant relation with the increase of the heart beat and decreased of the respiratory capacity (23). In a study which have conducted in 10 city of the North America, it was observed that for each increased in the CO and particle concentration respectively 2.79% and 2.4% added to the referred cardiovascular patients (9). In addition to it in a study which have done in Tucson (US) (2013) among the air pollutants, particles and CO respectively by 2.75 and 2.79 coefficient have a strict and significant relation with the rate of referred cardiovascular patients, while the other pollutants such as SO₂ and NO₂ and O₃ with the coefficient of 0.14%, 0.69% and 0.54% have a weak relation with the rate of referred cardiovascular disease (24). However, in some of the past studies there have been variable results in comparison with the present study's results. For example in a study which have done in 2013 among the evaluated pollutants, accumulative increase of 5 ppb in NO₂ concentration caused the increase of 12% in mortality rate which caused by cardiovascular disease (25). In a few studies there have not been a relation between air pollutants and cardiovascular disease. For example in an ecological study which have done in Scotland (2012) there wasn't a significant relation between suspended particles (PM_{2.5} and PM₁₀) and the rate of referred cardiovascular disease (26). The reason of the difference in the obtained results is the differences in the type of the study, statistical population, climatic condition differences and also the cultural difference of the evaluated place, which all these factors have an significant role in causing the differences. Therefore, according to the fact that there have not been a study with this regard in Kermanshah, the results of the present study could be used in scientific communities.

Conclusion

the present study have conducted like many other ecologic study which have done in past and it is an emphasis on the fact that the air pollutants particularly CO and less than 10 μ m particle respectively have an improper effect on the cardiovascular patients and caused the increased of the referral to the hospitals. Therefore, at the day which the concentration of these two pollutants is high, the individuals who exposed to the risk particularly elderly people and cardiovascular patients should take some safety measurements and not leave the house and in the case of leaving house they should avoid strenuous physical activity. In addition to it, according to the fact that at low temperature, there is a potential for exacerbation of the disease on cold day, they should observed the precaution. The government should take some long-term action such as regulating some strict environmental action to reduce the air pollution and cardiovascular disease.

Acknowledgements

The authors gratefully acknowledge the Research Council of Kermanshah University of Medical Sciences (Grant Number: 90166) for the financial support. The authors would like to thank Kermanshah Meteorological Organization, Kermanshah Department of Environment and Imam Ali hospital officials for the material support.

References

- 1- Khamutian R., Najafi F, Soltanian M, Shokoohizadeh M. J, Poorhaghighat S, Dargahi A, Sharafi K and Afshari A. The association between air pollution and weather conditions with increase in the number of admissions of asthmatic patients in emergency wards: a case study in Kermanshah. Medical journal of the Islamic Republic of Iran. 2015; 29(1):1-8.
- 2- Khamutian R, Sharafi K, Najafi F and Shahhoseini M. Association of Air Pollution and Hospital Admission for Cardiovascular Disease: A Case Study in Kermanshah, Iran. Zahedan Journal of Research in Medical Sciences. 2014; 16(11):43-46.
- 3- Sharafi K, Khosravi T, Moradi M and Pirsahab M. Air Quality And Variations In Pm10 Pollutant Concentration In Western Iran During A Four-Year Period (2008-2011), Kermanshah-A Case Study. Journal of Engineering Science and Technology.2015; 10(1): 47-56.
- 4- Jalaludin B, Morgan G, Lincoln D, Sheppard V, Simpson R and Corbett S. Associations between ambient air pollution and daily emergency department attendances for cardiovascular disease in the elderly (65+ years), Sydney, Australia. Journal of Exposure Science and Environmental Epidemiology. 2006; 16(3): 225-237.

- 5- Franchini M and Mannucci P. Short-term effects of air pollution on cardiovascular diseases: outcomes and mechanisms. *Journal of Thrombosis and Haemostasis*. 2011; 5(11):2169-2174.
- 6- Biggeri A, Bellini P and Terracini B. Meta-analysis of the Italian studies on short-term effects of air pollution--MISA 1996-2002. *Epidemiologia e prevenzione*.2003; 28(4-5): 4-100.
- 7- Zanobetti A, Schwartz J, Samoli E, Gryparis A, Touloumi G, Peacock J, Anderson R H, Le Tertre A, Bobros J and Celko M. The temporal pattern of respiratory and heart disease mortality in response to air pollution. *Environmental health perspectives*. 2003; 111(9):1188.
- 8- Gholizadeh M, Farajzadeh M and Darand M. The correlation between air pollution and human mortality in Tehran. *Hakim Research Journal*. 2009; 12(2): 65-71.
- 9- Ballester F, Tenias J and Perez-Hoyos S. Air pollution and emergency hospital admissions for cardiovascular diseases in Valencia, Spain. *Journal of epidemiology and community health*. 2001; 55(1): 57-65.
- 10- Burnett R T, Dales R E, Brook J R, Raizenne M E and Krewski D. Association between ambient carbon monoxide levels and hospitalizations for congestive heart failure in the elderly in 10 Canadian cities. *Epidemiology*. 1997;2(1):162-167.
- 11- Arfaenia H, Moradi M, Sharafi K, Mahdi Esfahan N, Dobaradaran S. Evaluation of Public Health Impacts Related To Urban Air Pollution In Shiraz And Bushehr, Iran. *International Journal of Pharmacy & Technology*. 2015; 7(3): 9811-9824.
- 12- Gwynn R C, Burnett RT and Thurston G D. A time-series analysis of acidic particulate matter and daily mortality and morbidity in the Buffalo, New York, region. *Environmental health perspectives*. 2000; 108(2):125.
- 13- Mirzaei N, Arfaenia H, Moradi M, Mohammadi Moghadam F, Velayati A, Sharafi K(2015). The Statistical Analysis Of Seasonal And Time Variations On Trend of Important Air Pollutants SO₂, O₃, NO_x, CO, PM₁₀-In Western Iran: A Case Study.*International Journal of Pharmacy & Technology*. 2015; 7(3): 9610-9622.
- 14- Watanabe M, Yamasaki A, Burioka N, Kurai J, Yoneda K, Yoshida A, Igishi T, Fukuoka Y, Nakamoto M and Takeuchi H. Correlation between Asian Dust Storms Worsening Asthma in Western Japan. *Allergology International*. 2011; 60(3): 267-275.
- 15- Sezavar S, Valizadeh M, Moradi Lakeh M. and Rahbar M. Early myocardial infarction and its risk factors in patients admitted in Rasul-e-Akram Hospital. *Bimonthly Journal of Hormozgan University of Medical Sciences*. 2010; 14(2):156-163.

- 16- Linn W S, Szlachcic Y, Gong J H, Kinney P L and Berhane K T. Air pollution and daily hospital admissions in metropolitan Los Angeles. *Environmental health perspectives*. 2000; 108(5): 427.
- 17- Reitsma J, Dalstra J, Bonsel G, Van Der Meulen J, Koster R, Gunning-Schepers L and Tijssen J. Cardiovascular disease in the Netherlands, 1975 to 1995: decline in mortality, but increasing numbers of patients with chronic conditions. *Heart*.1999;82(1):52-56.
- 18- Feldman D E, Thivierge C, Guerard L, Dery V, Kapetanakis C, Lavoie G and Beck E J.Changing trends in mortality and admissions to hospital for elderly patients with congestive heart failure in Montreal. *Canadian Medical Association Journal*.2001;165(8):1033-1036.
- 19- Municipality T. Air pollution and in-hospital mortality of ischemic heart disease patients. *Journal of Biological Sciences*.2010; 10(2): 117-121.
- 20- Rodríguez-Artalejo F, Guallar-Castillón P, Banegas J B and Del Rey Calero J. Trends in hospitalization and mortality for heart failure in Spain, 1980–1993. *European heart journal*. 1997;18(11):1771-1779.
- 21- Brown L F, Yeo K, Berse B, Yeo T-K, Senger D. R, Dvorak, H F and Van De Water L. Expression of vascular permeability factor (vascular endothelial growth factor) by epidermal keratinocytes during wound healing. *The Journal of experimental medicine*. 1992; 176(5): 1375-1379.
- 22- Morris R D and Naumova E N. Carbon monoxide and hospital admissions for congestive heart failure: evidence of an increased effect at low temperatures. *Environmental Health Perspectives*. 1998; 106(10): 649.
- 23- Cakmak S, Dales R, Leech J and Liu L. The influence of air pollution on cardiovascular and pulmonary function and exercise capacity: Canadian Health Measures Survey (CHMS). *Environmental research*. 2011; 111(8): 309-1312.
- 24- Beelen R, Hoek G, Van Den Brandt P A, Goldbohm R A, Fischer P, Schouten L J, Armstrong B and Brunekreef B. Long-term exposure to traffic-related air pollution and lung cancer risk. *Epidemiology*. 2008; 19(5): 702-710
- 25- Willocks L J, Bhaskar A, Ramsay C N, Lee D, Brewster D H, Fischbacher C M, Chalmers J, Morris G and Scott E M. Cardiovascular disease and air pollution in Scotland: no association or insufficient data and study design? *BMC public health*. 2012; 12(1): 227.

Corresponding Author:

Kiomars Sharafi*

Email:kio.sharafi@gmail.com