

## Relationship between Weather Components in Polluted Days and the Number Of Hospitalization Due to Cardiovascular Diseases

Abdolazimi A.<sup>1</sup> *PhD*, Gandomkar A.\* *PhD*, Ghias M.<sup>2</sup> *PhD*

\*Department of Geography, Najafabad Branch, Islamic Azad University, Najafabad, Iran

<sup>1</sup>Department of Geography, Najafabad Branch, Islamic Azad University, Najafabad, Iran

<sup>2</sup>Department of Planning, Geography Science & Rural Planning Faculty, Isfahan University, Isfahan, Iran

### Abstract

**Aims:** Air is the combination of atmospheric components or physical conditions of the current atmosphere in a certain place and a certain time. The aim of this study was to assess the relationship between weather components, air atmospheric pollutants and the number of individuals that were hospitalized due to cardiovascular diseases in polluted days.

**Instrument & Methods:** In this descriptive study during 2010 to 2013, the weather parameters in ground and upper levels of Isfahan City, Iran, weather stations were studied and air quality data were collected from 11 different points of the city. The number of cardiovascular patient that were hospitalized was determined by collecting the data of medical record department of 3 hospitals of Isfahan City, Iran; Shahid Chamran, Al-Zahra, and Ali-Asghar. Data were analyzed by SPSS 19 software using Pearson correlation.

**Findings:** There were significant correlations between the number of hospitalizations and minimum temperature ( $r=0.943$ ;  $p=0.0001$ ), maximum temperature ( $r=0.973$ ;  $p=0.0001$ ), average temperature ( $r=-0.069$ ;  $p=0.013$ ), rainfall ( $r=-0.326$ ;  $p=0.0001$ ), humidity ( $r=-0.326$ ;  $p=0.0001$ ), air pressure ( $r=0.257$ ;  $p=0.0001$ ), and wind speed ( $r=-0.011$ ;  $p=0.021$ ). There was a significant difference between the average numbers of hospitalizations due to cardiovascular diseases according to the range of AQI. Regarding the air pollutant parameters, the only significant relation was observed for PM10 ( $p=0.004$ ) and other factors showed no significant relation ( $p<0.05$ ) to the numbers of hospitalizations.

**Conclusion:** The number of hospitalizations due to cardiovascular diseases is just affected by the PM10 factor of air pollution.

### Keywords

Climate [<https://www.ncbi.nlm.nih.gov/mesh/68002980>];

Air Pollution [<https://www.ncbi.nlm.nih.gov/mesh/68000397>];

Cardiovascular Diseases [<https://www.ncbi.nlm.nih.gov/mesh/68002318>]

---

\* Corresponding Author

Tel: +98 (31) 42292112

Fax: +98 (31) 42292016

Post Address: Department of Geography, School of Humanities, Azad University of Najaf Abad, University Boulevard, Najaf Abad, Isfahan, Iran

[aagandomkar@iaun.ac.ir](mailto:aagandomkar@iaun.ac.ir)

Received: July 29, 2016

Accepted: November 11, 2016

ePublished: December 28, 2016

## Introduction

Air is the combination of atmospheric components or physical conditions of the current atmosphere in a certain place and a certain time and with its resulting procedures on the scale of a day, a week or a month [1]. Weather condition of a location is determined by recording various atmospheric components, e.g. temperature, rainfall, cloudiness, sunshine, wind speed and direction, etc. Meteorology, as a long-established field of study, has been always engaged with other majors, e.g. agriculture, forestry, hydrology, geology, transport, urbanization, sanitation, diseases, etc. Therefore, climate changes, development of urbanization, and urban air pollution are paramount topics in this field [2].

At the present time, humankind and its actions are known as the most effective cause of climate changes around the globe. Growing cities and development of urbanization along with expansion of industrial activities and the excessive use of fossil fuels, logging, and spread of particles have drastically increased the pollution and caused alteration in the combination of gases, which are vital for life on earth. The results have reflected back in human being itself and the spread of cardiovascular, respiratory, lung and eye diseases are examples of this fact. However, temperature and rainfall has proven by medical studies to be the 2 most effective factors on human health [3]. On the other hand, one of the other important issues that meteorology has been faced from a long time ago is air quality in big cities, like Isfahan.

Presence of pollutants, e.g. dust, gases, smoke, vapor, chemicals, etc., in big cities are extremely harmful for human and animals [4]. Hence, human and natural environment are greatly influenced by weather conditions. The World Health Organization defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity". It is obvious that a numerous aspect of this well-being depends on climate changes. In respect to this matter, different researches have been conducted in Iran [5]. For instance, cardiovascular diseases are normally found in individuals who are exposed to intense cold or hot weather conditions [6]. Correspondingly, it is clear that climate is one of the fundamentals of planet

earth and so, nature, humankind, and life are undeniably influenced by climate conditions [7].

Human heart is nothing but a pump, composed with muscles with a size of a fist which pumps 300 liters per minute and 180 millions of liters of blood in a life time, with a certain pressure, through the veins to distribute oxygen and nutrition to the body [8]. Arteries are responsible for sending nutrition to the different parts of the body, including heart itself. The narrowing or occlude of arteries can cause special diseases; known as cardiovascular diseases [9]. Studies show that narrowing or blockage of arteries can lead to sudden stop in effective blood flow or cardiac arrest, since one of the physical methods for body temperature adjustment in reaction to cold environment is through contraction of arteries [10]. Also, it has been demonstrated by many researchers that the stress caused by temperature can be an effective factor in mortality. It has been seen that as the temperature goes beyond the thermal comfort, stress and cardiovascular disease and subsequently death rate goes higher [11].

Epidemiological investigations on the relation of air pollution and cardiovascular diseases show that the most life-threatening complications of air pollution are on cardiovascular diseases [12]. Epidemiology of cardiovascular patients in hospitals of Jahrom city, Iran, in 2012 has shown that Angina pectoris was the most common heart disease and high blood pressure was the most common vascular disease [13]. Studies on atmospheric pollutant indicate that there is a significant relationship between the presence of these pollutants and heart failure [14, 15].

A study has reviewed the relationship between hospital admission of patients and heart failure with air pollution action days in Taiwan and concludes that hospital admission rate in hospitals of Taipei will follow an upward trend in days in which air pollution (caused by greenhouses houses gases) is more than other days [16].

Studies on relationship between mortality and air pollution in Toronto using regression models on cardiovascular and respiratory patients have shown that there is a significant relationship between air pollution variables and death caused by aforementioned diseases [17]. Medical studies on effects of atmospheric

components on disease reveal that with increase and decrease of temperature or with change of seasons, certain disease e.g., cardiorespiratory, heart rhythm and Asthma will spread [18]. Scientists have investigated the effects of air pollution on human body and death rate relating to this matter in Europe and came to conclusion that death rate, caused by air pollution, have had an increasing trend [19].

Epidemiological studies on community health have showed a relationship between global climate change and our health. In fact, shortage of Omega-3 in our diet which originates from climate change is in association with increase of cardiovascular diseases, cancer, diabetes, stress and heart disease [20]. A study on the relationship between temperature and heart disease in cold seasons in Astana, Kazakhstan, was carried out using Poisson regression model with 0-15 intervals and barometric pressure control. The results denoted that there is a positive and significant relationship between average and minimum of temperature and mortality from cardiovascular disease [21].

In order to investigate the possible effect of wind-chill on death rate, a study in the U.S. on the days in which the number of death was higher than others has shown that the relationship between temperature, barometric pressure and rainfall is statistically positive and significant [22].

Air pollution and inherited cardiovascular diseases were studied using logistic models on statistical data of 2000-2006. The tests were done to evaluate the relationship between air pollution and the risk to fetus in third to eighth week of pregnancy on a target group of 527-635 women. The pollutants caused by carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, and dust particles with a diameter less than 2.5 and 10 micrograms/m<sup>3</sup> as a risk factor to cardiovascular diseases were also studied [23].

The results of a study on the relationship between weather, air pollution, and cardiovascular diseases acknowledged that there is a significant relationship between the increase of air quality index and reduction of life expectancy in large cities of Asia, Africa, and Latin America. This is because with the increase of air pollution, the risk factors, e.g. blood pressure and high blood sugar, will

increase in cardiovascular diseases and children/middle aged, respectively [24].

As we can see, human and natural environment are influenced by climate change to a great extent. For that reason, cardiovascular diseases often emerge in people who are in the intensive exposure to hot or cold weather [25]. In addition to weather components, one of the other important issues that meteorology has been facing from a long time ago is air quality in Isfahan. There is a mixture of pollutants including dust, gases, smoke, vapor, chemicals, etc. in the air and they are harmful for human other living creatures in big cities. In order to discuss that, the relationship between weather components in air polluted days in Isfahan with the number of hospitalization due to cardiovascular disease was studied. The aim of this study was to assess the relationship between weather components, air atmospheric pollutants and the number of individuals that were hospitalized due to cardiovascular diseases in polluted days.

## Instrument & Methods

In this descriptive study during 2010 to 2013, the weather parameters in ground and upper levels of Isfahan City, Iran, weather stations were studied and air quality data were collected from 11 different points of the city (Azadi, Laleh, Bozorgmehr, Emam Hossein, Ahmad Abad, Shohada, Engelab, Bank Sepah, Elyaderan, Vahid, and Khajoo).

In order to determine the thermal effect in Isfahan, the measured parameters in weather station of Isfahan were used. The number of cardiovascular patient that were hospitalized was determined by collecting the data of medical record department of 3 hospitals of Isfahan City, Iran; Shahid Chamran, Al-Zahra, and Ali-Asghar.

Data were analyzed by SPSS 19 software using Pearson correlation to assess the relationship between effective weather components and number of cardiovascular hospitalizations and to compare the average of air pollutants according to AQI.

## Findings

There were significant correlations between the number of hospitalizations and minimum temperature ( $r=0.943$ ;  $p=0.0001$ ), maximum

temperature ( $r=0.973$ ;  $p=0.0001$ ), average temperature ( $r=-0.069$ ;  $p=0.013$ ), rainfall ( $r=-0.326$ ;  $p=0.0001$ ), humidity ( $r=-0.326$ ;  $p=0.0001$ ), air pressure ( $r=0.257$ ;  $p=0.0001$ ), and wind speed ( $r=-0.011$ ;  $p=0.021$ ).

There was a significant difference between the average numbers of hospitalizations due

to cardiovascular diseases according to the range of AQI. Regarding the air pollutant parameters, the only significant relation was observed for PM10 ( $p=0.004$ ) and other factors showed no significant relation ( $p<0.05$ ) to the numbers of hospitalizations (Figure 1).

**Figure 1)** The average of air pollutants and number of hospitalizations due to cardiovascular diseases

AQI Range	Number of days	O <sub>3</sub> (ppm)	NO <sub>2</sub> (ppm)	PM10 (µg/m <sup>3</sup> )	SO <sub>2</sub> (ppm)	CO (ppm)	Number of hospitalizations
1-50	63	0.065±0.011	0.085±0.010	200.2±34.5	0.099±0.023	7.6±0.5	59.4±11.3
51-100	814	0.087±0.015	0.044±0.015	258.5±41.2	0.104±0.019	4.7±0.9	60.1±10.5
101-150	329	0.063±0.012	0.086±0.022	489.7±64.8	0.112±0.021	10.4±1.1	100.9±14.7
151-200	43	0.085±0.021	0.076±0.017	380.4±45.5	0.121±0.029	9.9±0.9	88.2±12.1
201-300	4	0.043±0.008	0.070±0.016	328.7±39.1	0.101±0.031	9.4±1.2	75.3±11.0
p Value	-	p=0.08	p=0.078	p=0.004	p=0.5	p=0.07	p=0.037

## Discussion

The findings of the study demonstrate that based on AQI in Isfahan, PM10 had the most impact on increasing the hospitalization due to cardiovascular diseases. The results of Pearson correlation indicate that correlation coefficients for minimum temperature, maximum temperature, average temperature, rainfall, relative humidity, air pressure, and wind speed are all have significant correlation with the hospitalization due to cardiovascular diseases.

Shabani & Ezzatiyan have shown that dryness of air in Isfahan has significant relation with increasing of Meningitis. Also the increasing level of air pollutants more than the standard level causes more heart diseases. Meanwhile high barometric pressure and the resulting low temperature increased the amount of heart disease patients compared to other disease [26]. It seems that exposure to pollutants increases the number of hospitalizations of heart disease patients especially in cold season.

Furthermore, there was a significant correlation between increase of maximum and minimum temperature and air pressure and number of hospitalization due to cardiovascular diseases. Mohammadi *et al.* have reported a diverse relationship between temperatures and a direct relationship between barometric pressures with the mortality of heart disease patients [27]. Another evaluation by Jahan Bakhsh *et al.* in Ahar County, Iran, shows that temperature is related to heart attack occurrence. Accordingly, reduction of temperature leads

to contraction of coronary arteries and heart muscles and increase of cardiovascular symptoms and associated health impacts [7]. It can also be inferred that increasing of temperature and reduction of relative humidity will result in high blood pressure and associated health impacts, following by increase of number of hospitalization. This is because of expansion of industries, urbanization, migration to cities, and finally excessive use of fossil fuel that have caused air pollution in Isfahan.

The aforementioned factors, along with changes in combination of gases, which affect human health, have endangered people health in cities, especially people with heart illness. This also has increased the number of acute syndrome, shortness of breath caused by presence of particles in respiratory tract, more pressure on heart which leads to mitral valve stenosis, and finally hearth attack. In addition, high numbers of hospitalization in cold season denoted that when body is exposed to intensive cold, the immune system is no longer able to resist and gradually hypothermia will occur, followed by drop of body temperature. The individual will experience a mild dizziness, problems in speech and making decisions, and incoordination in muscle movements [18]. Hypothermia is often followed by progressive deterioration of brain condition, atrial and ventricular arrhythmia, low pulse and respiration rate, dilated and unresponsive pupils, and lack of voluntary movement.

In equal conditions (in term of genetic, health, nutrition, physical activity and other factors

which may have impact on cardiovascular disease), atmospheric pollutant and weather components in Isfahan intensify number of hospitalization due to cardiovascular disease. It is recommended that the government take the idea of replacing fossil fuels by alternative energies more seriously and put this matter in first priority in their municipal and environmental policies and investment.

## Conclusion

The number of hospitalizations due to cardiovascular diseases is just affected by the PM10 factor of air pollution.

**Acknowledgements:** The authors would like to thank anyone from different organizations who helped in this path including Alzahra, Shahid Chamran and Hazrat Ali Asghar hospitals. In addition, the authors would like to express special thanks to Dr. Victoria Ezzatian and her passionate colleagues from Isfahan Meteorological Organization.

**Ethical Permissions:** None declared by authors.

**Conflicts of Interests:** None declared by authors.

**Funding/Support:** This article is derived from the PhD thesis. The study was registered with a code number of 294030.

## References

- 1- Nadafi K. Air pollution. 1<sup>st</sup> edition. Tehran: No Avarne Elm; 2009. [Persian]
- 2- Mohammadi H. Climatic dangers. 1<sup>st</sup> edition. Tehran: Tehran University Publications; 2008. [Persian]
- 3- Kargar M, Kaheh D. Air pollution. 1<sup>st</sup> edition. Tehran: Khaniran; 2013. [Persian]
- 4- Ghias-al-din M. Traffic pollution and its effects on community. Tehran: Researches from the Second Conference on Traffic in Tehran; 2001, May 12. [Persian]
- 5- Bigdeli A. The relationship between climatic parameters and air pollution on hearth attack in a 5-year period in Tehran from 1990 to 1994. *Geogr Stud J*. 2001;5(16):126-40. [Persian]
- 6- Mohammadi H. The relationship between climatic elements and air pollutants in tehran with death rate caused by cardiovascular disease. *Geogr Res*. 2006;58(4):47-64. [Persian]
- 7- Jahan Bakhsh S, Tadayoni M, Salmanpour R, Jahan Bakhsh E. The relationship between air temperature and hearth attack in Ahar, Iran. *Phys Geogr*. 2009;5(3):29-35. [Persian]
- 8- Meade MS, Emch M. Medical geography. 3<sup>rd</sup> edition. New York: Guilford Press; 2010.
- 9- Goldberg MS, Burnett RT, Bailar JC 3<sup>rd</sup>, Brook J, Bonvalot Y, Tamblin R, et al. The association between daily mortality and ambient air particle pollution in Montreal, Quebec. 2. Cause-specific mortality. *Environ Res*. 2001;86(1):26-36.
- 10- Faraj Zadeh M, Razeghi M, Fathniya A, Ahmad Abadi A. Analysis of variability Iran tourism climate index in drought and wet year. *Q Geogr*. 2009;1(1):57-71. [Persian]
- 11- Ghasemi M. Air pollution and cardiovascular disease. *Iran Atheroscler Assoc; J Sci Artic*. 2011;12(4):2-4. [Persian]
- 12- Shahsavari S, Nazari F, Karimyar Jahromi M, Sadeghi M. Epidemiologic study of hospitalized cardiovascular patients in Jahrom hospitals in 2012- 2013. *Cardiovasc Nurs J*. 2012;2(2):14-20. [Persian]
- 13- Behnamoon M, Garagyaraghi M, Sadeghi M. Investigating air pollution and heart defect. *J Med Fac*. 2014;38(3):152-6. [Persian]
- 14- Momeni M, Faal Ghoyumi A. Statistical analysis using SPSS. 7<sup>th</sup> edition. Tehran: Simaye Danesh Press; 2012. [Persian]
- 15- Isfahan Urban Air Monitoring. Isfahan: Department of Environment of Isfahan Province; 2013.
- 16- Yang CY, Hsieh HJ, Tsai SS, Wu TN, Chiu HF. Correlation between air pollution and postneonatal mortality in a subtropical city: Taipei, Taiwan. *J Toxicol Environ Health A*. 2006;69(2):2033-40.
- 17- Araina MA, Blaira R, Finkelsteina N, Brookb JR, Sahsuvaroglua T, Beckermanc B, et al. The use of wind fields in a land use regression model to predict air pollution concentrations for health exposure studies. *Atmos Environ*. 2007;41(16):53-64.
- 18- Burton I, Ebi KL, McGregor G. *Biometeorology for adaptation to climate variability and change (Volume 1)*. Dordrecht: Springer; 2009.
- 19- Krzyzanowski M, Cohen A, Anderson R. Quantification of health effects of exposure to air pollution. *Occup Environ Med*. 2002;59(12):791-3.
- 20- Kang JX. Omega-3: A link between global climate change and human health. *Biotechnol Adv*. 2011;29(4):388-90.
- 21- Grjibovski AM, Nurgaliyeva N, Kosbayeva A, Menne B. No association between temperature and deaths from cardiovascular and cerebrovascular diseases during the cold season in Astana, Kazakhstan – the second coldest capital in the world. *Int J Circumpolar Health*. 2012;71:10.
- 22- Allen MJ, Sheridan SC. High-mortality days during the winter season: comparing meteorological conditions across 5 US cities. *Int J Biometeorol*. 2014;58(2):217-25.
- 23- Agay-Shay K, Friger M, Linn S, Peled A, Amitai Y, Peretz C. Air pollution and congenital heart defects. *Environ Res*. 2013;124:28-34.
- 24- Gold DR, Samet JM. Air pollution, climate, and heart disease. *Circulation*. 2013;128:e411-4.
- 25- Ezatian V. Study of the impacts of meteorological parameters on the air quality index in the city of Isfahan [Dissertation]. Isfahan: University of Isfahan; 2008. [Persian]
- 26- Shabani Sh, Ezzatiyan V. The relation between disease with climate elements and atmosphere pollutants in Isfahan. *Sepehr*. 2014;20(4):47-57. [Persian]
- 27- Mohammadi H, Khosh Akhlagh F, Golizadeh N. Statistical analysis of air pollutants and atmospheric elements associated with dead people due to heart diseases. *J Stud Hum Settl Plann*. 2016;10(33):1-11. [Persian]