

Association of Air Pollution and Hospital Admission for Cardiovascular Disease: A Case Study in Kermanshah, Iran

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Abstract

Background: The objective of the present study was to estimate the contribution of environmental pollutants to hospital admissions for cardiovascular disease (CVD) on subjects living in Kermanshah.

Materials and Methods: This study is an ecological analysis. Data of CVD was collected from the largest CVD hospital of Kermanshah during 1 March 2010 until 30 February 2011. The air pollution data were obtained from environmental center. Magnitude of association was estimated by Poisson regression model.

Results: Among air pollutants PM₁₀ and CO was significantly associated with hospital admission for CVD.

Conclusion: This study suggests that short-term exposure of people with some air pollutants such as PM₁₀ and CO could increase CVD hospital admission.

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Introduction

Over the past 50 years, humans have changed natural ecosystems more rapidly and extensively than in any comparable period in human history.

Outdoor air pollution that is caused predominantly by the combustion of non-renewable fossil fuels for electricity generation, transport and industry is responsible for significant mortality every year, mostly as a result of heart and lung diseases [1].

According to the World Health Organization, air pollution leads to 3 million premature deaths annually. On the other hand, cardiovascular disease (CVD) is considered the most common cause of death and disability around the world [2].

Among numerous factors with major contribution to CVD, air pollution is an environmental factor with an important role to cause and increase CVD [3].

However, despite definite improvements in air quality, the negative effects of air pollution are still an important public health problem. The impact of air pollution on several out-comes have been extensively reported in developed countries such as North America [4, 5], Northern or Western Europe [6, 7] and Australia [8].

In developing countries because of lack of sustainable development, air pollution is still one of the major problems that without precise control of pollution sources and applying restrict policies, air pollution remained unsolved problem and even it will be worse [9].

According to the World Health Organization, 3 most polluted cities located in Iran, and Kermanshah is 1 of these 3 cities that located in west of Iran. The major sources of pollution in Kermanshah include the

petrochemical industry, power plants and cement factories. Furthermore, in recent years entry of dust storms derives from neighboring countries (Iraq and Saudi Arabia) have intensified the city's air pollution.

Up to now the effect of air pollution on CVD morbidity has not been studied in Kermanshah, a city that has its own special characteristics in terms of weather, ecosystem and cultural condition. In this study we explore the short-term association between air pollution levels and hospital admissions for cardiovascular diseases in Kermanshah, Iran, for the period 2010-2011.

Materials and Methods

This study is an ecological type that was conducted in the capital and largest city of Kermanshah province in western Iran and located at 34° 18' latitude North and 47° 4' longitude east. The city has a total area of about 8,547 km² which had approximately 980,786 inhabitants by 2011.

Based on the statistical results of meteorological data, in the mentioned years prevailing wind direction in winter and second half of autumn was south east, but in the rest of the year was the west. The average wind speed during the year was 6.7 knots. Winds were lighter in winter than those during the rest of the year.

Data on daily hospital admissions for CVD was collected from 1 March 2010 to 30 February 2011 from the largest and referral center for CVD in Kermanshah city, named Imam Ali hospital. Generally, over 80% of local residents mainly choose this hospital for diagnosis

and treatment of CVD. During the period of study all of the CVD data was collected.

The air pollution data during the study period were obtained from the Kermanshah Environmental Monitoring center. The center is part of a nationwide network of monitoring stations and reports daily observations to the Iran Environmental Monitoring Chief Station. The daily concentrations of each pollutant were averaged from the available monitoring results of 3 fixed stations located in the urban district of Kermanshah. Pollutants estimated by this station are SO₂, PM₁₀, O₃ and NO₂.

Meteorological data, relative humidity, daily temperatures, barometric pressure, rainfall were obtained from meteorological office monitoring site in central Kermanshah.

The statistical analysis was carried out using SPSS-21 software. The description of each variable in terms of valid number of mean, minimum and maximum observation values and standard deviation were calculated.

The Pearson correlation coefficients were used to evaluate the inter-relations between air pollutants and weather conditions. As the number of daily hospital admission data belongs to a kind of small probability event and has a Poisson distribution. The generalized linear model (GLM) Poisson regression approach (multivariate and univariate model) was used to explore the associations of major air pollutants and weather factors with daily hospital admissions for cardiovascular disease. The daily number of admissions for cardiovascular diseases was considered as a dependent variable, and air pollutants (such as PM₁₀, SO₂, O₃, CO and NO₂) plus climatic variables (daily median temperature, barometric pressure, humidity and rainfall) were considered as independent variables.

Results

A total of 36,659 cardiovascular hospitalizations occurred during the 365 days of the study (From March 1, 2010 to February 30, 2011). During the period, the average concentrations of PM₁₀, SO₂ and NO₂, CO and O₃ were 143.10 µg/m³, 24.6 ppb and 38.25 ppb, 1.86 ppm and 40.7 ppb, respectively. Among the gasses pollutants, the average annual concentration of PM₁₀ was higher than WHO air pollution standard.

Table 1 gives the correlation coefficients for the air pollutants and meteorological variables. Most of such variables are significantly correlated together. While NO, NO₂ and CO had a strong positive correlation with each other, most pollutants had strong negative correlation with temperature and rainfall but positive correlation with pressure. The results showed maximum number of hospitalization occurred in January and winter.

Table 2 shows association between hospital admission change due to cardiovascular disease and increase of air pollutants and weather variables in multivariate and univariate model for the whole period.

In the univariate Poisson model (GLM) all of the weather variables and pollutants except SO₂ had significant association with CVD hospitalization (Table 2). Results of multivariate model showed among pollutants, exposure to CO and particulate matter were significantly associated with hospitalization for CVD admission. Among weather variables mean barometric pressure had positive association with hospitalization, but temperature and rainfall had negative association with hospitalization for cardiovascular diseases in both univariate and multivariable analysis (Table 2).

Table 1. Pearson correlation analysis of air pollutants and weather variables during the period analyzed

	O ₃ (ppb)	NO ₂ (ppb)	NO (ppm)	PM ₁₀ (µg/m ³)	SO ₂ (ppb)	CO (ppm)
O ₃ (ppb)	1	-0.58	-0.69	0.58	0.006	-0.622
<i>p</i> -Value	-	0.001	0.001	0.001	0.001	0.001
NO ₂ (ppb)	-0.58	1	0.88	-0.58	0.14	0.67
<i>p</i> -Value	0.001	0.001	0.001	0.001	0.001	0.001
NO (ppm)	-0.69	0.88	1	-0.63	-0.19	0.85
<i>p</i> -Value	0.001	0.001	-	0.001	-	0.001
PM ₁₀ (µg/m ³)	0.58	-0.58	-0.63	1	-0.19	0.38
<i>p</i> -Value	0.001	0.001	0.001	-	0.01	0.13
SO ₂ (ppb)	0.006	0.14	-0.199	-0.19	1	-0.35
<i>p</i> -Value	0.14	0.15	0.18	0.015	-	0.001
CO (ppm)	-0.62	0.67	0.85	0.38	-0.35	1
<i>p</i> -Value	0.001	0.001	0.001	0.001	0.001	-
Temperature (°C)	0.709	-0.49	-0.32	-0.642	-0.06	-0.44
<i>p</i> -Value	0.001	0.001	0.001	0.001	0.14	0.001
Rainfall (mm)	-0.607	-0.69	-0.67	-0.509	-0.156	-0.719
<i>p</i> -Value	0.001	0.001	0.001	0.001	0.13	0.001
Pressure (Pa)	-0.79	0.57	0.59	0.904	0.136	0.344
<i>p</i> -Value	0.001	0.001	0.001	0.001	0.1	0.12
Humidity (%)	-0.67	0.429	0.29	-0.60	0.086	0.29
<i>p</i> -Value	0.001	0.001	0.48	0.001	0.88	0.27

Table 2. Association between hospital admission due to cardiovascular disease and air pollutants and weather variables in univariate and multivariate model

Parameter	Univariate model RR (95% CI)	Multivariate model RR (95% CI)
NO (ppm)*	1.006 (1.001 to 1.011)	-
NO ₂ (ppb)	1.0075 (1.003 to 1.012)	0.994 (0.987 to 1.001)
PM ₁₀ (µg/m ³)	1.0065 (1.003 to 1.010)	1.006 (1.004 to 1.007)
CO (ppm)	1.17 (1.12 to 1.23)	1.123 (1.042 to 1.21)
O ₃ (ppb)	1.009 (1.004 to 1.014)	1.003 (0.999 to 1.008)
SO ₂ (ppb)	1.005 (0.997 to 1.004)	0.999 (0.997 to 1.001)
Humidity (%)	1.005 (0.998 to 1.012)	1.002 (0.997 to 1.006)
Temperature (°C)	0.991 (0.985 to 0.975)	0.989 (0.987 to 0.992)
Rainfall (mm)	0.902 (0.836 to 0.972)	0.956 (0.937 to 0.976)
Pressure (Pa)	1.037 (1.023 to 1.051)	1.05 (1.039 to 1.059)

*NO was removed due to collinearity with NO₂ and CO

Discussion

Based on the results of multivariate Poisson regression, among air pollutants and weather conditions, PM₁₀, CO and low temperatures significantly associated with the number of hospital admission for cardiovascular disease in Kermanshah.

According to studies from elsewhere; such as those carried out in Sydney [8] and Atlanta [10], air pollutants

have stronger effect on hospital admission because of CVD in cold season.

Our findings of significant associations of PM₁₀ and CO with cardiac admission are in line with those in many European and North American cities [4-7]. Despite the observed association between CO and PM₁₀ with hospital admission due to CVD, there is no unanimous agreement about association between NO₂, SO₂ and O₃ with such conditions. While some investigations have denied such association [4], other studies have shown different results [11].

Several physiopathological pathways have been proposed for the relationship between air pollution (like CO and PM₁₀) and cardiovascular health; CO and PM₁₀ can change autonomic nervous system control as assessed by heart rate [12]. In addition, an increase in daily concentrations of PM₁₀ and CO was associated with rise in plasma fibrinogen (an acute phase proteins) and subsequently increase in viscosity of plasma (that is a risk factor of CVD) [13]. Furthermore, CO by forming carboxy hemoglobin decreases the exercise capacity in patients with coronary artery disease [14].

This study similar to other ecologic studies suffers from some limitations. For example, we cannot make sure that people hospitalized for CVD are exactly those exposed to air pollutants, but Kermanshah is not a very big city, so it can be assumed that air pollution is seen uniformly in the entire city because of geographical situation of Kermanshah. Considering that until now in Kermanshah, no study has been conducted to assess contribution of environmental pollutants to cause related disease, this ecologic study could be a start to identify some factors affecting human health in Kermanshah, but it is recommended prospective and intervention studies, with more statistical power, to be designed in the future in this field.

The present study as well as most previous ecological studies conducted indifferent countries, emphasis that air pollutants, particularly carbon monoxide, and then particles less than 10 µm could exacerbate cardiovascular

disease and lead to increase hospital admission for CVD diseases.

Considering the results of this study which underscores the unfavorable impact of air pollution on public health and given that Kermanshah has been one of the most polluted city in recent years, the government should apply long-term procedures and programs, including the establishment of stricter environmental regulation to make premises of reducing air pollution and consequently reduction of CVD. As a temporary solution, in the days with high levels of air pollution sensitive and vulnerable people especially the elderly and patients with CVD should do safety precautions and if leave their home avoid strenuous physical activity. Moreover, at lower temperature during cold weather, that likely to intensify the CVD disease, they should do further caution.

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Authors' Contributions

Razieh Khamutian and Kiomars Sharafi participated in design, drafting and writing the manuscript. Farid Najafi participated in statistical analysis and drafting the manuscript. Mansoureh Shahhoseini cooperated in data collection.

Conflict of Interest

The authors declare no conflict of interest.

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