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The Relation between Air Pollution and Cardiorespiratory Admissions in Tehran

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ABSTRACT

Background: *Air pollution is a major horror in many cities in Iran especially in Tehran. The cost of traffic congestion in the capital is put at two billion hours of time wasted each year. Tehran has also recorded SO_2 levels four times the standard prescribed by the World Health Organization. Tehran is the capital of the Islamic Republic of Iran with almost 11 million inhabitants (one sixth of the country's population), and is the most densely populated city of the country. The purpose of this research was to investigate the effects of air pollution on cardiorespiratory system. We assessed the relationship between the levels of air pollutants and emergency visits for asthma and cardiovascular diseases in Tehran, Iran. Two research questions investigated in this study were as follows: a) Which criteria elements of hazardous toxic air pollution were associated most strongly with the level of hospital admissions for cardiorespiratory conditions? b) What proportion of the variation in hospital admissions for cardiorespiratory conditions was explained by variations in levels of air pollution?*

Materials and Methods: *During a 12-month period (from April 2004 to March 2005), the concentrations of 5 air pollutants (CO , NO_2, O_3, SO_2 and PM_{10}) were measured in four stations located in north, west, south and central part of Tehran. The level of air pollution was calculated according to PSI (Pollution Standard Index).*

Results: *Based on the results obtained during the study period, concentration of CO was reported as "above standard" on most of the days, leading to an "unhealthy" situation. 51.9% of measurements were made at PSI≤100 and standard conditions. 34.7% of measurements were at "unhealthy" levels with PSI= 101- 200. 13.2% of measurements were in "very- unhealthy" conditions with PSI= 201- 300. and 0.2% of measurements were recorded in one station and in a "hazardous" condition with PSI>300.*

For ozone (O_3), all measurements were at standard conditions, PSI≤100. The concentration of SO_2 on most of the days was at "standard" condition. Only 6% of the measurements (2 samples) were at "unhealthy" or "hazardous" levels, PSI=101-200.

Regarding particulate matter (PM10), all samples were evaluated as 88.7% of the measurements were at standard conditions with PSI≤100 while 11.3% of the measurements showed "unhealthy" condition with PSI=101-200.

Conclusion*: It was observed that carbon monoxide and particulate matter were the main air pollutants in Tehran that had levels higher than standard values. The results showed that the number of admissions because of cardiopulmonary complaint was positively correlated with concentration of all studied pollutants except for ozone (O_3). The main source for these air pollutants was motor vehicles. It is notable that atmospheric condition along with geographical situation of Tehran help augment the air pollution in this city. Thus, in addition to encouraging the use of CNG as the combustion material for cars, buses and minibuses, other extensive measures should be implemented in this regard.*

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Key words: *Air pollution, Respiratory, Admission, Tehran*

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INTRODUCTION

Air pollution is the biggest environmental problem that Iran currently faces especially in the capital city of Tehran. About 1.5 million tons of pollutants are produced in Tehran annually, with carbon monoxide from car exhaust making up a large percentage of these pollutants. Tehran's air pollution is made even worse by its geographic position. The city is hemmed in by mountains to the north and east, causing the increasing volume of pollutants to become trapped, hovering over Tehran when the wind is not strong enough to blow the pollution away. Tehran's high altitude, ranging between 3,300 and 5,000 feet, also makes fuel combustion inefficient, adding to the pollution problem. The combination of these natural and artificial factors causes Tehran to be one of the most polluted cities in the world, accompanied by Mexico City, Beijing, Cairo, Sao Paulo, Shanghai, Jakarta, and Bangkok (1,2).

Air pollution levels in the most populated cities are amongst the highest in the world, producing serious human health impacts and affecting aquatic and terrestrial ecosystems. Air pollution in all its forms - including sulfur dioxide, ozone, fine particles, carbon monoxide, and nitrogen oxides – is a serious threat for human health (3-8) In Poland, scientists collected information from more than a half-million army-induction medical examinations conducted between 1979 and 1981 at 241 induction centers throughout the nation. Centers with air polluted by sulfur dioxide reported four times more asthma and three times more bronchitis than centers without the pollution (4,6,7,9,10).

The nature of spatial variation in the relationship between air pollution and health outcomes within a city remains an open and important question (12).

Air pollution contributes to preventable illness and death. Subgroups of patients who appear to be more sensitive to the effects of air pollution include children, the elderly, and people with existing chronic cardiac and respiratory diseases such as coronary artery disease, chronic obstructive pulmonary disease and asthma. It is unclear whether air pollution contributes to the development of asthma, but it has been found that air pollution does trigger asthma episodes (4,8,10).

Hwang et al. investigated the association between daily air pollution levels and emergency room (ER) visits for respiratory and cardiac diseases in Taipei city, Taiwan from January 1997 to December 1998. The purpose of the investigation was to assess the contribution of ambient air pollutants to acute health effects. Pollutants measured were particulate matter less than 2.5 μm in aerodynamic diameter (PM2.5), PM_{10}, carbon monoxide, sulfur dioxide, nitrogen dioxide, and ozone (13).

We conducted parallel analysis of the short-term association between air pollution and daily hospital admission in Tehran to understand short-term health effects of air pollution.

MATERIALS AND METHODS

During a 12-month period from April 2004 to March 2005, the concentrations of 5 air pollutants included CO, NO_2, O_3, SO_2, and PM_{10} were measured in four stations located in the North, the West, the South, and central part of Tehran. The levels of air pollutants were compared by calculating the values of the *Pollution Standard Index* (*PSI*).

The daily admissions for acute respiratory conditions to the emergency departments of four major hospitals together with the daily concentrations of the major pollutants were measured. The air data were provided by the Air Quality Control Company of Tehran, Municipality and by the National Research Institute of Tuberculosis and Lung Disease. Masih Daneshvari Hospital was responsible for providing the day-to-day data from four zones of air quality monitoring stations in Tehran for measuring the amount of above-mentioned pollutants.

The analytical techniques employed in the data collection process were (a) UV fluorescence for SO_2, (b) chemi-luminescence's reaction for NO_2, (c) infrared absorption for CO, (d) UV photometric for O_3, and (e) filter absorption for PM_{10}.

The data were collected continuously in four ambient air monitoring stations in Tehran. The stations are located in various dispersed parts of Tehran. The monitoring (sampling and analysis) was carrying out continuously, but the data for each day covered a 24-hour period, beginning and ending at 10 a.m each day.

In this study four stations (out of seven stations in Tehran), located in densely populated areas within the city, and continuously collected hourly data.

CO, O_3, NO_2, SO_2 and PM_{10} gas analyzer instruments in stations of Azadi (South), Gholhak (North), and Sorkhe-Hesar (East) belonged to Department of Environment (DOE). The instruments used were Horiba 360 manufactured in Japan. Fatemi station is under supervision of Municipality of Tehran. The instrument used was the Thermo-Environment manufactured in the United States.

The Ambient SO_2 Monitor is a microprocessor controlled analyzer with automatic calibration using an external gas dilution and calibration gas standards.

Particulate Matter 10 (PM_{10}) was measured by the True micro weighing method at Fatemi station, as well as by the Beta Radiation method for the other three stations.

In a cross-sectional method, the number of cardiopulmonary admissions in emergency wards of different hospitals in Tehran and level of air pollutants of CO, NO_2 O_3, SO_2, and PM_{10}, were measured, and their correlations were assessed. Monthly admissions due to cardiopulmonary complaint to emergency wards of Tehran hospitals were collected from medical record achieve of each hospital. The data were collected daily and reported monthly by the statistics division of medical record archive of the hospitals. Data of different pollutants including CO, SO_2, NO_2, O_3 and PM_{10} were prepared daily from Coordinator Center of Air Pollution Informatics in Tehran which is in collaboration with Ministry of Health, Meteorological Organization, Air Quality Control Company, and Organization of Bioenvironmental Protection of Tehran Province.

All the pollution and admission data were collected for 12 months from April 2004 to March 2005.

The analyses were conducted in two parts. For each station the data of pollutants were plotted against time (day).

The data on a monthly basis were available for the entire 12 months. Thus, the regression analyses were based on 12 months data.

RESULTS

The correlation coefficients between (a) particulate matter and hospital admissions for cardiorespiratory problems and (b) carbon monoxide and hospital admissions for cardiorespiratory problems were greater than 70 percent ($r>0.70$).

According to the Iranian Ministry of Health, the PSI values are divided into four groups: standard (0-100), unhealthy (101-200), very unhealthy (emergency) (201-300), and hazardous. The PSI and the percentages were calculated for different pollutants. Tables 1 through 5 have summarized the percentages of each pollutant for each station.

The total results were as follows:

- CO: 54.9 % standard condition, 35.2% unhealthy, 9.8% very unhealthy and 0.3% hazardous condition.
- O_3: 100% standard condition for all stations.
- SO_2: 98.6% standard condition and 1% unhealthy condition.
- NO_2: 100% was standard condition for all stations.

The results demonstrated that the number of admissions because of cardiopulmonary complaint was positively correlated with concentration of all studied pollutants except ozone (O_3), and its correlation was statistically significant with carbon monoxide (CO) and PM_{10} ($r = 0.73$, $p = 0.016$, $r = 0.75$, $p = 0.012$, respectively).

The correlations between levels of the five criteria variables measured and hospital admissions for cardiorespiratory conditions are presented in Table 1.

Table 1. Correlations between pollutants and hospital admissions.

		NO. of admissions	CO	O_3	NO_2	SO_2	PM-10
NO. of admission	Pearson Correlation	1.000	0.731*	-0.340	0.574	0.424	0.752*
	Sig. (2-tailed)	.	0.016	0.336	0.083	0.222	0.012
	N	10	10	10	10	10	10
CO	Pearson Correlation	0.731*	1.000	0.081	0.797**	0.194	0.947*
	Sig. (2-tailed)	0.016	.	0.825	0.006	0.562	0.000
	N	10	10	10	10	10	10
O3	Pearson Correlation	-0.340	0.081	1.000	0.068	-0.458	-0.002
	Sig. (2-tailed)	0.336	0.825	.	0.852	0.183	0.996
	N	10	10	10	10	10	10
NO2	Pearson Correlation	0.574	0.797**	0.068	1.000	-0.117	0.711*
	Sig. (2-tailed)	0.083	0.006	0.852	.	0.748	0.021
	N	10	10	10	10	10	10
SO2	Pearson Correlation	0.424	-0.194	-0.458	-0.117	1.000	-0.124
	Sig. (2-tailed)	0.222	0.592	0.183	0.748	.	0.733
	N	10	10	10	10	10	10
PM-10	Pearson Correlation	0.752*	0.947**	-0.002	0.711*	-0.124	1.000
	Sig. (2-tailed)	0.012	0.000	0.996	0.021	0.733	.
	N	10	10	10	10	10	10

*. Correlation is significant at the 0.05 level (2- tailed).

**. Correlation is significant at the 0.01 level (2- tailed).

DISCUSSION

A major environmental concern in the contemporary period is global warming. Conservative governments continually attempt to deny either the reality or global warming or to deny that human actions are the cause of the phenomenon if it is occurring. In addition, industrialization is associated with environmental pollution which is hazardous to human health. Air pollution is increasing in big cities especially in developing countries, which leads to cardio-respiratory diseases (5,13,15,16).

Preserving the environment has been a major objective for environmentalists. The future, however, may demand that reclaiming the environment is given attention equal to preserving what is left of nature (17-19).

According to the 1995 scientific assessment report of the "Intergovernmental Panel on Climate Change" (IPCC), “the body of statistical evidence now points towards a discernible human influence on global climate” (Intergovernmental Panel on Climate Change, 1995, p. 5). This influence is due to the increase in atmospheric concentrations of greenhouse gases since pre-industrial times, and the effect of this increase on the energy balance of the Earth (10,20).

Peng et al. investigated the relation between coarse particulate matter air pollution and hospital admission for cardiovascular and respiratory diseases among patients. The result was 3.7 million cardiovascular and 1.4 million respiratory disease admissions. A 10 microgram/m^3 increase in PM 2.5-10 was associated with 0.36% increase in

cardiovascular disease admissions on the same day (14).

In 2003, a study was performed in Tehran to detect the effect of air pollution on acute respiratory conditions and the results demonstrated that a correlation was observed between the number of hospital admissions for asthma and the weekly mean concentration of nitrogen dioxide. The 3 day and 10 day mean concentrations of sulphur dioxide were also found to be directly correlated with the number of asthma admissions during this period (21).

In our study the correlation analysis identified carbon monoxide and particulate matter as the main elements of air pollution that were strongly associated with hospital admissions for cardiorespiratory problems.

Similar to the results of our study, another research performed in Tehran by Hossienpoor and his colleagues indicated that daily admissions due to angina pectoris were significantly related to the CO level after controlling for confounding factors (22).

The correlation analyses, however, did not establish causal relationships between the criteria elements of air pollution and hospital admissions for cardiorespiratory problems.

Sherwin RP of the University of Southern California in his study in 1991 on autopsies of Los Angeles accident victims aged 14 to 25 yrs found that some had severe lung lesions of the sort caused by ozone (23). Another study in New York showed when ozone levels increased, admissions at 87 hospitals in New York City and 35 in Buffalo jumped by 25 to 30 percent. In contrast, our research showed that the number of admissions because of cardiopulmonary complaints was positively correlated with concentration of all studied pollutants except ozone (O_3). Within minutes of entering the lungs, ozone burns through cell walls. The human immune system rushes to defend the lungs, but the defensive cells, too, are stunned by the ozone. Cellular fluid seeps into the lungs and breathing becomes rapid, shallow, and painful. In the nose and airways, ozone destroys normal ciliated cells, which the body then replaces with squat, thick-walled, abnormal squamous cells (4,9,10,11).

The technical scenario offers substantial potential for reducing CO_2 emissions; however, these benefits are achieved at a relatively high cost per ton in comparison with the average abatement cost derived from other scenarios. If additional technological measures are implemented it might be possible to reduce CO_2 emissions by 40 percent by the year 2020 compared to previous levels in 1987 (24, 25).

Based on the results of this study it was observed that carbon monoxide (CO) and particulate matter were the main air pollutants in Tehran. The main source for these air pollutants was vehicles. It is notable that atmospheric condition along with geographical situation of Tehran help augmenting air pollution in this city. Thus in addition to encouraging the use of CNG as combustion material for cars, buses and minibuses, other extensive measures should be implemented in this regard. More studies are needed to evaluate the effect of different pollutants on acute cardio respiratory admissions.

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