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Evaluation of 5 Air Criteria Pollutants; Tehran, Iran

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ABSTRACT

Aims Tehran's uncontrolled expansion, which promoted housing, public utilities, industries and increase of vehicles caused the problem of air pollution. Necessary information about air quality in different places and different times is the first step of combating the air pollution. The purpose of this study was to investigate the annual, monthly and hourly average of 5 criteria air pollutants (PM10, O3, NO2, SO2, CO) of Tehran City, Iran.

Instrument & Methods The hourly concentrations of PM10, O3, NO2, SO2, CO were obtained from 21 air quality-measuring stations of Tehran City, Iran, during April 2012 to March 2013. Data were presented by descriptive statistics in the form of mean and standard deviation.

Findings CO concentration was not changed during the period of study. Nitrogen dioxide increased in spring and winter. Sulfur dioxide was not changed in the first six months of the year but its concentration increased in winter. Trend of changes of floating particles showed increasing the concentration of this pollutant in May 2012 and January 2013. Ozone concentration increased in the warm seasons and decreased in the cold seasons.

Conclusion PM10, O3, NO2, SO2 and CO has high concentrations and cold periods of the year are more polluted than the warm periods in Tehran City, Iran.

Keywords Air Pollution; Ozone; Carbon Monoxide; Nitrogen Dioxid; Sulfur Dioxide; Tehran

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Introduction

Existence of one or some pollutants such as dust, odor, smoke and fume in open air with different quantities and characteristics are dangerous for human, plant or animal life [1]. Air quality as water quality, affects the public health [2]. Terrible effects of air pollution in the twentieth century caused severe health problems in Europe and America [3]. According to World Health Organizations' reports, air pollution has caused 4.6 million health problems and 800000 deaths worldwide each year. 56% of overall pollution problems were occurred in Asian developing countries that revealed air pollution as a serious problem in these countries [4]. Air pollution causes 5 times more deaths than diseases like Malaria [5]. Many studies show that acute exposure to air pollutants causes temporary health hazards like eye irritation, respiratory and cardiovascular disorders and early death [6-9].

The industrial revolution, started about 200 years ago, results in air pollution in urban areas. Industrialization and growth of cities caused increasing severity of air pollution. Basic reliance on energy resources such as coal, oil and gas that their combustion release air pollutants caused harmful effects [10]. According to AQ index of air pollutants, pollutants include Carbon monoxide (it is a toxic gas from cars which use petrol), Sulfur dioxide (mainly refers to fuel oil which is used in some central heating and power production industries and installations), Nitrogen dioxides (mainly refers to fuel oil, gasoline and partially refers to petrol and kerosene consumption), non-burned hydrocarbons (mainly refers to cars which use petrol. Fuel oil and gasoline are less effective in this case), floating particles (particles mainly from fuel burning) [11] and Ozone (it is a gas which its main reaction occurs in troposphere) [12].

Tehran City, the capital of Iran, is now known as one of the most polluted cities in the world which has the high portion of educational, administrative, social and cultural activities [1]. Although Tehran City, Iran, has expanded just in 1.2% of Iran area, it holds approximately 20% of the total population, 40% of the industry and 85% of experts [5]. Air pollution of Tehran City, Iran, is resulted from expansion and growth of the city, increasing of the population, constructing the new houses, factories, industrial units and gigantic increase of vehicles [13]. Air quality investigation in different areas of Tehran City, Iran, in 2003 showed that its air has about 15-30ppm CO while according to 8 hours CO standard in breathing air; it must not be more than 9ppm. Results of that study also showed that areas generally in downtown and old parts of the town had the highest concentration of CO and were highly polluted [5]. In the present situation of the country that Tehran City is considered as the center of the country's decision making and where most of the country's policies and laws are made, purification of its air and making a proper environment for thinking and making decisions should be an essential strategy of the country [14].

The purpose of this study was to investigate the annual, monthly and hourly average of 5 criteria air pollutants (PM10, O_3, NO_2, SO_2, CO) of Tehran City, Iran.

Instrument & Methods

In this descriptive-cohort study during April 2012 to March 2013, the hourly concentrations of PM10, O_3, NO_2, SO_2, CO were obtained from 21 air quality-measuring stations of Tehran City (Figure 1).

Figure 1) The geographic location and type of 21 air quality-measuring stations of Tehran City, Iran

Order	Name of stations	Type of stations
1	Aghdasie	residential
2	Punak	residential
3	2nd Area	traffic
4	Tarbiat Modares	residential
5	Golbarg	residential
6	Masudieh	residential
7	Shahrerey	residential
8	Rose Park	traffic
9	4th Area	residential
10	10th Area	traffic
11	11th Area	residential
12	16th Area	residential
13	19th Area	residential
14	Fath	traffic
15	Daroos	residential
16	Mahallati	residential
17	Sharif	residential
18	New Tehransar	residential
19	Shadabad	residential
20	Piruzi	residential
21	Setade Bohran	residential

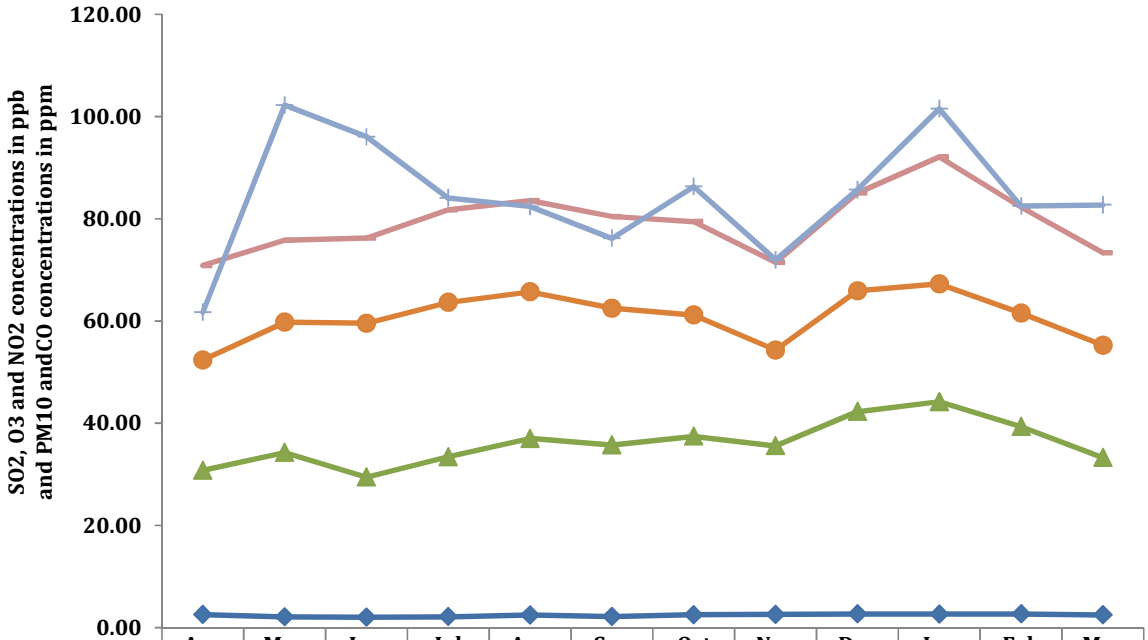
CO concentration was measured by standard method of non–dispersive infrared spectroscopy (GFC-IR), ozone concentration based on Beer-Lambert's law, nitrogen

oxidants concentration by camilomincent phenomenon, SO_2 concentration by UV fluorescent and floating particles smaller than 10 micrometers in diameter by decrease in Beta's radiation absorption.

Data were entered to Excel 2007 software and were presented by descriptive statistics in the form of mean and standard deviation.

Findings

CO concentration was not changed during the period of study. The highest concentration was in December 2012 (2.67±0.66ppm) and the lowest was in June 2012 (2.05±0.51ppm). The highest concentrations of CO were in Shadabad and Punak. Nitrogen dioxide pollutant increased in spring and winter and the lowest concentrations were in June 2012 (29.45±6.92ppb) and March 2012 (30.77±5.87ppb) but the highest concentration was in January 2013 (44.18±8.34ppb). The highest concentration of pollution for nitrogen dioxide was recorded in the 4th district of municipality and Tarbiat Modares stations. Sulfur dioxide pollutant was not changed from April to November but its concentration increased in January (24.85±4.13ppb) and February (20.76±5.90ppb) 2013. The lowest concentration was in May 2012 (16.06±3.77ppb). The highest concentration of this pollutant was seen in 16th and 19th districts of municipality and Aghdasieh stations. Trend of changes of PM10 in this period showed increasing the concentration of this pollutant in May 2012 (100.11±14.65ppm) and January 2013 (98.90±17.29ppm). The highest concentration of PM10 was seen in Tehransar and Fath stations. Ozone pollutant's concentration increased in the warm seasons and decreased in the cold seasons; The highest concentration was in June 2012 (30.09±3.74ppb) and the lowest was in November 2012 (18.76±2.38ppb). Punak and Rose park stations had the highest concentration of this pollutant (Figures 2 and 3).



	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
SO2	18.47	16.06	16.67	18.11	17.86	17.94	18.31	17.13	19.12	24.85	20.76	18.07
O3	21.61	25.49	30.09	30.21	28.70	26.75	23.69	18.76	23.63	23.08	22.21	21.99
NO2	30.77	34.26	29.45	33.41	36.99	35.74	37.46	35.56	42.28	44.18	39.32	33.27
PM10	59.19	100.11	94.00	81.94	79.92	74.01	83.77	69.39	83.01	98.90	79.83	80.23
CO	2.54	2.10	2.05	2.12	2.46	2.18	2.52	2.56	2.67	2.65	2.67	2.49

Figure 2) Monthly trend of changes of 5 criteria pollutants in Tehran City, Iran, from April 2012 to March 2013

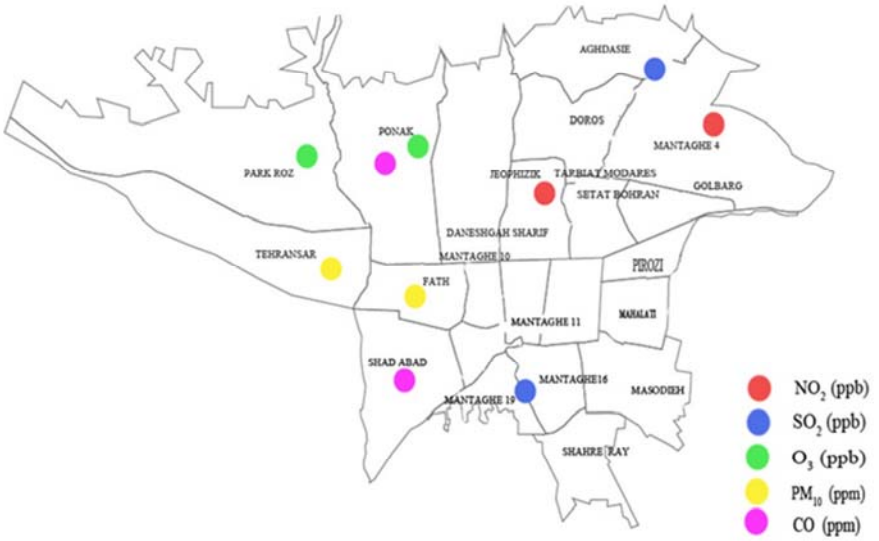


Figure 3) Distribution of annual concentration average of 5 criteria pollutants in Tehran City, Iran, from April 2012 to March 2013 in air quality control stations

According to hourly investigation, all the pollutants except SO_2 and O_3 had two peaks (one in the early morning and the other late at night) during the day. The minimum concentrations of pollutants were recorded in the afternoon. CO and NO_2 pollutants had one peak of concentration from 7am to 9am (2.82±0.77ppm and 41.35±21.56ppb, respectively) and the other from 9pm to 11pm (3.35±0.93ppm and 44.27±20.25ppb, respectively). Floating particles smaller than 10 micrometers in diameter had the lowest concentration at 3pm to 5pm (77.39±24.28ppm) but in 8am to 10am (88.35±26.08ppm) and 10pm to 2am (91.40±27.98ppm) had the highest concentration. The cleanest hours of the day for all pollutants were 3pm to 5pm (36.43±9.59ppb) while it was the most polluted hour for Ozone. The highest concentration of SO_2 was seen at 11am and 12am.

Peak concentration of Ozone (36.05±9.66ppb) was observed at the time of the most radiation (12am to 4pm) that was exactly after NO_2 peak. With the decrease of NO_2 concentration, ozone concentration increased and the minimum concentration of ozone (13.25±6.93ppb) was recorded in the early hours of the day (Figure 4).

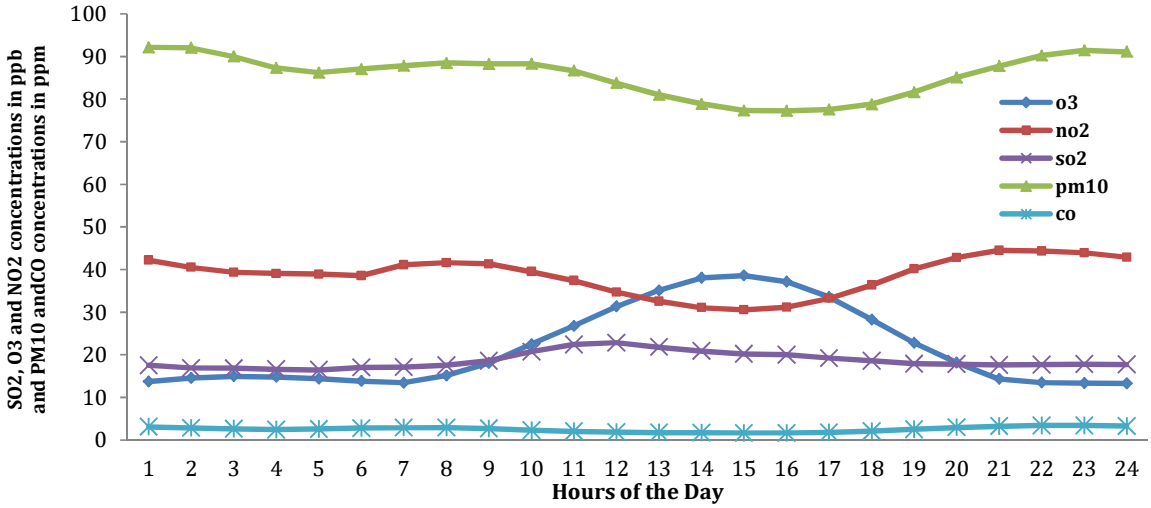


Figure 4) Hourly trend of changes of 5 criteria pollutants of Tehran City, Iran, from April 2012 to March 2013

Discussion

There were no significant changes in the CO concentration all the year. Comparing the result of this study with the study of Mansouri & Abadi, similar results of CO concentration changes in different months of the year is obtained [15]. Also results of this study are the same as the study of Khamutian *et al.* [16].

Changes of nitrogen dioxide's concentration that has two peaks, one in the cold season and the other in the warm season, showed that this pollution is not only subordinate to vehicles fuel and other oxidizer instruments, but it has direct relation with weather condition, temperature and season of the year. In Shariepour study also NO_2 rate in warm and cold seasons have maximum rates [17] which has the same result as this study. Also results of Shariepour & Bidokhti are compatible with this study. Nitrogen dioxide had 2 peaks of concentration, one in May 2012 and the other in November 2012 [18].

The study's findings showed that sulfur dioxide has one peak of concentration in winter which its main reason can be increasing of fuel consumption for heating and also vehicle fuels. This result is compatible with Shariepour's study [17].

Surveys on concentration of floating particles showed that in the beginning and at the end of 2012 this pollutant's concentration increases. Increasing the wind speed, occurrence of dust phenomenon, decrease of rainfall and not washing out the particles in the spring, are some of the reasons. Mansouri & Abadi have shown that the concentration of PM10 in summer more than standard due to the lack of wind [15]. Also Safavi & Alijani have reported the concentration of floating particles as the highest in June, July and August 2012 [14].

In the spring and summer, because of increasing the photochemical reactions of nitrogen oxides with hydrocarbons, rate of the ozone production had increased. Ghiasodin & Sourati have found the average ozone concentration lowest in December and highest in April [19]. Khamutian *et al.* have reported the highest concentration of ozone in June, August and September, respectively [16]. Shariepour shows a peak of ozone in the spring [17]. Also peak of ozone's concentration in the time of maximum sunlight radiation (12 to 16) exactly after peak of NO_2 is seen. Ozone concentration increases by decreasing the nitrogen dioxide concentration, because ozone precursors are NO_2 and sunlight radiation. Morning peak of CO is because the car engines are cold and combustion of fuel occurs incompletely and the night peak is because of recreational driving during the night [12].

According to hourly trend of concentration changes of NO_2 and CO that showed high concentration in the early morning and middle of night, it seems that mobile sources of air pollutants are more important than stationary sources in making and emission of these pollutants [20]. This finding is compatible with the trend of hourly changes of pollutants concentration in Shariepour study [17].

Result of studying the pollutants concentration in different areas of Tehran, Iran, showed that in Rose Park, Tehransar, Punak, Fath, Shadabad and 19th area of municipality stations, concentration of pollutants are more than other stations of the air quality control company. Existence of many industries and their improper locations can be one reason. The other reason is that since Alborz and Bibi Shahrbanu mountains act as the north and east walls of the city, western wind (the only wind of Tehran City, Iran) bring the industrial wastes to the city (there are 7000 industrial units in Tehran; 30% of which in the west, 54% in the south and 6% in the east) while the northern and eastern mountains block the way for the wastes brought by the western wind to get out of the city.

Low information of the concentration of air pollutants in some months in some of the stations was from the limitations of this study. It is suggested that air quality management becomes part of the development programs in all the urban areas. Extension of public transportation and using clean technologies can be useful in air pollution decrease.

Conclusion

PM10, O_3, NO_2, SO_2 and CO has high concentrations and cold periods of the year are more polluted than the warm periods in Tehran City, Iran.

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Ethical Permission: The Ethics Committee of Kashan University of Medical Sciences approved the study.

Conflict of Interests: We certify that there is no conflict of interest in this manuscript.

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