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Original Article

Estimation of health effects attributed to NO_2 exposure from the use of AirQ model in Ahvaz

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Abstract

Background & objectives: AirQ software proved to be a valid and reliable tool to estimate the potential short term effects of air pollution. In this study the AirQ2.2.3 model was used to evaluate adverse health effects caused by nitrogen dioxide(NO_2) exposure in Ahvaz during 2009.

Materials & Methods: The AirQ, developed by the World Health Organization (WHO) to predict health endpoints attributed to criteria pollutants and permits the examination of various scenarios in which emission rates of pollutants are varied. Nitrogen dioxide(NO_2) reacts with ammonia, moisture, and other compounds to form small particles. These small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory diseases, such as emphysema and bronchitis, and can aggravate existing heart disease, leading to increased hospital admissions and premature death.

Results: In the present study approximately 3%of total cardiovascular mortality, acute myocardial infarction and hospital admission of chronic obstructive pulmonary disease happened when the NO_2 concentration was more than 20μg/m^3.

Conclusions: Low percentage of observed health endpoints was associated to low concentration of measured NO_2. The lower level of RR value might achieve if some control strategies for reducing NO_2 emission were used. Therefore the higher RR value can depict mismanagement in urban air quality.

Keywords: Health endpoint; NO_2 concentration; AirQ model; Relative risk; Ahvaz

1. Introduction

Anthropogenic air pollution has been and continues to be viewed as a serious problem. Its seriousness lies in the fact that high, potentially harmful pollutant levels are produced in environments which can be harmful for human health. According to the WHO estimations 800000 people were died each year because of cardiovascular and respiratory diseases, which are attributed to air pollution, in all over the world.

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Approximately 150,000 of these deaths occur in the south of Asia. The result of these studies about short and long term effects of air pollution were estimated in the form of hospital admissions excess cases, increasing in a number of consultation with physician, asthma attacks, cardiopulmonary disease, death and number of the years lost (YOLL)[1-8]. Nitrogen dioxide is produced in the combustion process which takes place mostly in transportation, power stations, heating plants and industrial processes. NO_2 and NO summation are called NO_X. The major source of NO_X is road traffic. Although 50% of total NO_X emission is produced by road traffic, this percentage can be higher in megacities and metropolitans[9-11]. NO_2 can hurt lower parts of the respiratory system and at high concentrations, which may be occurred rarely at unprecedented industrial events and can lead to serious lung casualties.There are chronic and acute health effects which may be appeared by low and high NO_2 concentration exposure, respectively. High concentration of NO_2 can result in airway inflammation and this is why even healthy individuals show some anomalies in their respiratory system function. People with chronic obstructive pulmonary disease (COPD) or asthma attacks are more vulnerable at low concentration of NO_2[12-13]. Epidemiological studies have shown an association between NO_2 concentrations and health endpoints.In a multi-center case-cross-over study a 9.6μg/m^3 increase in the NO_2 concentration was associated with hospitalization for cardiovascular disease. In this study, increasing in hospital admission for cardiovascular disease, cardiac failure, ischemic heart disease and myocardial infarction were attributed to increase in the NO_2 concentration levels[14]. Again in anothercase-cross-over study, there was an association between NO_2 levels and mortality in patients who suffered from asthma exacerbation. In this study which was conducted in Spain, a 22.9 μg/m3 increase in the NO_2 concentration (minimum5.2 μg/m^3) was associated with mortality[15]. Positive associations were found between increases of 32μg/m3 at temperatures above 20ºC and hospital admissions for both primary intracerbral hemorrhage and ischemic stroke[16]. Next study has shown associations between hospital admissions for cardiovascular diseases and NO_2 for a 32 μg/m3 incremental increase[17]. Elevated odd ratios due to hospital admission for an increment of 10.5 μg/m3 NO_2 were observed among susceptible groups in a crossover study[18]. Recently, several studies have reported adverse health effects below the current exposure limits for NO_2 particularly in both children and the elderly individuals. In a study with long term exposure (1-year average),1.17, 1.57 were calculated as RR values with an increase of 16 μg/m^{3}in NO_2 concentration for all causes of death and cardiopulmonary disease,respectively. Again for the same increase of NO_2 concentrations in a long term exposure study (5-year average) relative risks of 1.19 and 1.74 were calculated for all causes of mortality and cardiopulmonary disease.

Patients and Methods

A specialized model, the air quality health impact assessment tool ($AirQ_{2.2.3}$), was used to assess the potential impactsof NO_2 exposure on human health in Ahvaz city during 2009. So, the mortality and morbidity of nitrogen dioxide in Ahvaz city in 2009 were calculated by $AirQ_{2.2.3}$ utilizing relative risk and baseline incidence from WHO data.NO_2 data was taken from Ahvaz Department of Environment (ADoE). These data were in volumetric base.Health effects were being related to the mass of pollutants inhaled and which is whythe AirQ model was on gravimetric basis. So,therewas a conflict between AirQmodel and ADoE data. Conversion between volumetric and gravimetricunits (correction of temperature and pressure), coding, processing (averaging) and filtering are implemented for solving such problem.

Correction for non-standard temperature and pressure

Raw air quality monitoring data were in a Microsoft Office Excel spreadsheet. Therefore, all processing mechanisms such as correction, coding, averaging and filtering were performed in this software. The temperature and pressure are unlikely to be standard, so we also need to be able to convert gravimetric units at STP to other temperatures and pressures. AtSTP, we have 1 m^3 containing a certain mass of material. When the temperature and pressure change, the volume of the gas changes but it still contains the same mass of material. Hence we need only to find the new volume from the Ideal GasEquation

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Where P_1, V_1 and T_1 are the initial pressure, volume and absolute temperature and P_2, V_2 and T_2 are the final pressure, volume and absolute temperature.
In our case:
P1= 1 atmosphere
V1= 1 m^3
T1= 273.15K
And we need to find V_2.
Therefore, rearranging equation below,

$$V_2 = \frac{T_2}{P_2} \times \frac{P_1 V_1}{T_1} = \frac{T_2}{273.15 \times P_2}$$

2-2- coding

We wrote a code in a column after date's column in spreadsheet excel. The objective for doing this was to facilitate a mechanism of averaging. In the first cell of code column cell the formula for coding was:
B3= Left (A3, 5)

To know what this formula means it should be noted that excel computes from date of Microsoft starting up till the first time of monitoring. Microsoft was founded in 1900. A count of the number of days from the first of 1900 till03/21/2007 and the sum will be almost exactly 39,162. It was apparent by clicking on format cell/number/custom. The term of mm/dd/yyyyhh: main type part was corresponded to 39,162 in sample part.

Table1. coding on basis of date

0	A(Date)	B(Code)	C(NO_2, $\mu g/m^3$)
1	03/21/2007 00:00	39162	164.01
2	03/21/2007 01:00	39162	174.57
3	03/21/2007 02:00	39162	165.98
21	03/21/2007 20:00	39162	111.59
22	03/21/2007 21:00	39162	110.12
23	03/21/2007 22:00	39162	107.91
24	03/21/2007 23:00	39162	73.47
25	03/22/2007 00:00	39163	81.77
26	03/22/2007 01:00	39163	53.90

Averaging

The routine method for providing 24 hours average is performed by clicking on f(x) icon. The insert function is appeares. The routine way takes more time when there is a huge number of data.To obtain the daily average of the pollutant at each station in the city writing: (IF (B26<>B27; AVERAGE (C3:C26)) command would be necessary. According to the code column, the figure of code will be changed after 24 hours so that there is a special code for each day. The formula can generalize to the next cells and columns in both directions (horizontally and vertically). A slight change in the command sentence of formula would be recommended if it will spreads horizontally. For example above conditional sentence must alter to:(IF (B26<>B27; AVERAGE (D3:D26)). Comparisonof these two conditional formulas implies that C changes to D for providing average in next column which belongs to the levels of NO_2 at the adjacent station. By dragging up and down dragging the conditional sentence will act to compute daily mean of nitrogen dioxide in all stations. Huge numbers of cells (23 of 24 cells) are filled by the word "false" which means the first part of a conditional sentence is not correct. Therefore, mean value is placed on 24 number cells which are repeated in every 24 cell intervals.

Primary filtering

Primary filtering was used for deleting "false" cells. The command: Data/Filter/Auto filter/Does not equal to false, is implemented to achieve 365 mean values of NO_2 concentrations at each station (Table 1).

Secondary filtering

According to model database, it is suggested to specify the highest and the lowest stations before using the secondary filtering. The station was considered as the highest when the mean value of this station is greaterthan the mean parameter at other stations and vice versa for the lowest.Therefore the lowest station should be selected i.e. the station that gives the lowest yearly average in the city for nitrogen dioxide concentration. In the next step, the column of all stations in the field of nitrogen dioxide concentration was built to make an appropriate background for secondary filtering. Then the air quality data weremade from filtering on the column of all stations. The aim of secondary filtering on the average column of all stations was to find concentration intervals of NO_2in 2007 year.

Results

The primary standard of nitrogen dioxide according to national ambient air quality standard (NAAQS) is 100μg/m^3 (NAAQS for air pollutant, Federal Register January 19, 2010). World health organization (AQG WHO) has recommended 40 and 200 μg/m^3 as annual and hourly means of NO_2 guidelines, respectively (http://www.euro.who.int/Document/E87950.pdf).
Table 1 shows that annual mean of NO_2 in Ahvaz was 27μg/m^3 in 2009 which is lower than AQG WHO and also much lower than NAAQS standards. In view of NO_2 concentrations, Havashenasy and Edarekolwere the highest and the lowest stations during this year respectively. The yearly average, summer mean, winter mean and 98 percentile of NO_2 concentrations in these stations is presented in table 2.

Table 2. NO2 concentrations in micrograms μg/m^{3}for use in Model

Stations / Parameter	lowest stations (Edarekol)	highest stations (Havashenasy)	Ahvaz
Annual mean	18	66	27
Summer mean	16	-	6
Winter mean	19	72	43
98 percentile	50	369	115

Relative risk and the estimated AttributableProportion percentage for acute myocardial infarctionwere estimated in table 3. According to the model's default, the baseline incidence (BI) of this health endpoint for NO_2 was 132 per 10^5 so the number of excess cases were estimated 9 at centerline of relative risk (RR=1.0036 and AP=0.6977%).

Table 3. Estimated relative risk indicators, and the component attributable to NO_2 cases attributable to acute myocardial infarction

Estimate / Indicator	RR (Medium)	Estimated AP (%)	Estimated number of excess cases (persons)
Down	1.0015	0.2919	3.7
Mean	1.0036	0.6977	8.9
Up	1.0084	1.6129	20.7

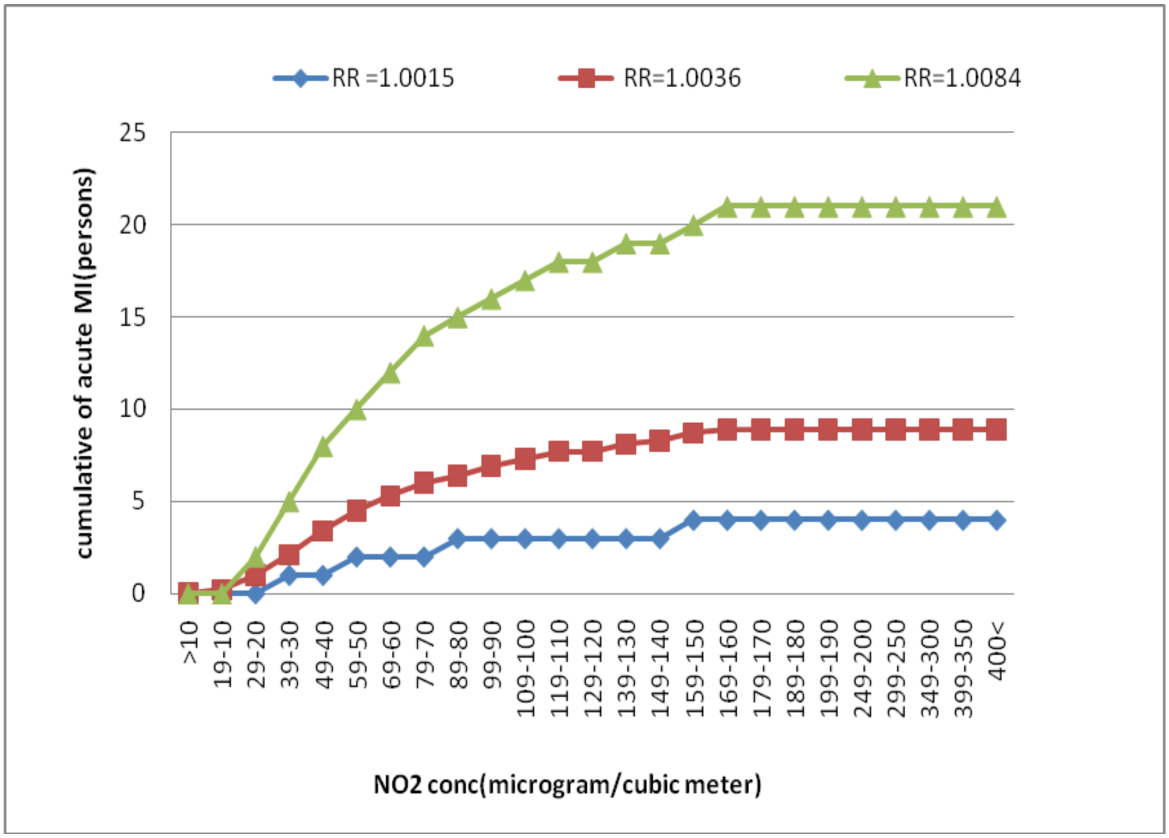

Figure1. Relationship between cumulative of acute MI versus NO_2 concentration

Figure 1 shows the cumulative number of acute MI versus NO_2 concentrations. Cumulative cases of this health endpoint wereestimated by the model which was9in 2009. 60% of this number has occurred in the days with concentrations lower than 70µg/m^3. It should be noted that 82% of above number are corresponded to the days with concentrations below 110µg/m^3.

Table 4. Estimated relative risk indicators, and the component attributable to NO_2 cases attributable to death from heart disease – cardiovascular

Estimate / Indicator	RR (Medium)	Estimated AP (%)	Estimated number of excess cases (persons)
Down	1	0.000	0.000
Mean	1.002	0.3888	18.7
Up	1.004	0.7746	37.3

Relative risk and the estimated Attributable Proportion percentage were estimated in table 4 for acute cardiovascular mortality. As mentioned earlier BI was taken from the model's default which is 497 per 10^5 for this health endpoint. Therefore, estimated number of excess cases were calculated 19 at centerline of relative risk (RR=1.002and AP=0.3888%).

Cumulative cases of cardiovascular mortality attributed to NO_2 concentrations has illustrated in Figure 2 with three ranges of relative risk.37 persons were estimated by model as the total cumulative number of cardiovascular deaths within one year of exposure. 60% of these cases have occurred in the days with NO_2 levels not exceeding 70µg/m^3.

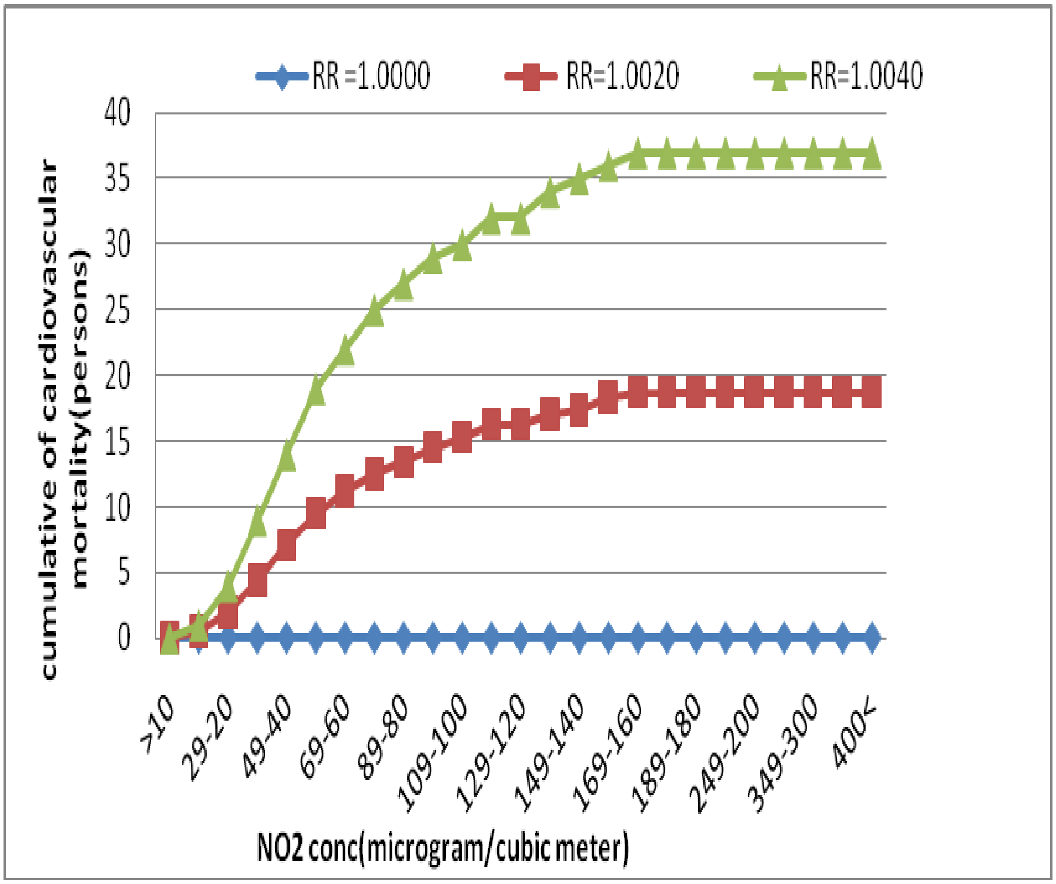

Figure 2.relationship between cumulative of cardiovascular mortality versus NO_2 concentration

Relative risk and the estimated Attributable Proportion percentage were estimated in table 4 for acute hospital admission of COPD. BI of this health endpoint is 101.4per 10^5, the estimated number of excess cases was8 at centerline of relative risk (RR=1.0038and AP=0.7361%)

Table 5. Estimated relative risk indicators, and the component attributable to NO_2 cases attributable to chronic obstructive pulmonary disease (COPD)

Indicator \ Estimate	RR (Medium)	Estimated AP (%)	Estimated number of excess cases (persons)
Down	1.0004	0.078	0.8
Mean	1.0038	0.7361	7.2
Up	1.0094	1.0094	17.7

Hospital admission of chronic obstructive pulmonary disease versus nitrogen dioxide concentration has been shown in figure 3.In this case the lowest line (RR=1.0004) is not attachedto X axis and it shows a subtledifference with figure 2. Estimated cases which attributed to NO_2 for hospital admission of COPD at lower, central and higherof RR were 1, 8 and 18, respectively(Table 5).

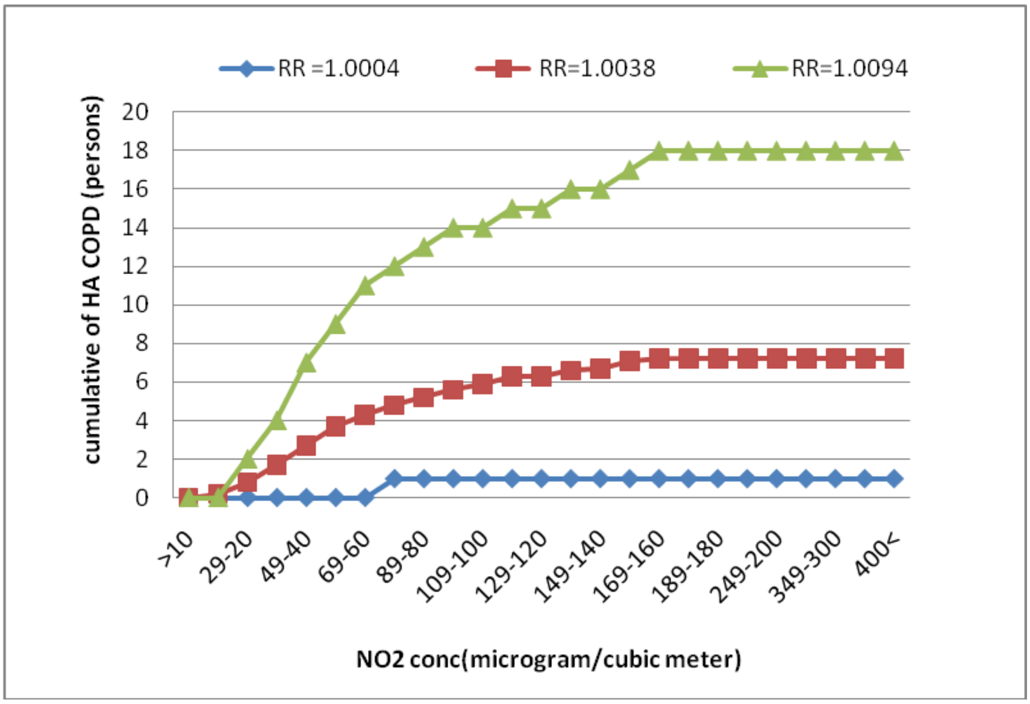

Figure 3- relationship between cumulative of hospital admission for COPD versus NO_2 concentration

Discussion

Figures 1 to 3 has illustrated NO_2 concentrations versus related health endpoint. As it has shown three ranges of relative risk based on model's default were considered in assessing health effects of NO_2.Furthermore BI values were also taken from default of the model. For our population of one million people and based on BI of 497 per 10^5 people per year, some 4970 cardiovascular mortality cases can be expected annually, out of this number, 19 can be attributed to the NO_2 concentration above 20µg/m³. 82% of MI cases occurred in the days with pollutant not exceeding 110µg/m³. In cardiovascular mortality 77% of cases occurred in days with pollutant not exceeding 100 µg/m³ and 66% of COPD cases occurred in the days with pollutant not exceeding 80µg/m³.Although cardiovascular mortality had the lowest RR in centerline in comparison with MI and COPD, high number of this health endpoint cases was due to its higher BI value (497 per 10^5). In the other hand, the greater number of acute cardiovascular mortality cases in comparison to MI cases was related to more BI for acute cardiovascular mortality.Even in comparison between MI and COPD, BI had a paramount of importance than RR. In the interpretation of RR it should be noted that 1 for this epidemiological parameter implies no impact on human health. In addition, severe effects can be expected when it exceeds from1.Lack of cardiovascular mortality was referred tocalculatedRR value (1) and that is why the lowest line is attachedtothe X axis. It was also associated with being zero for both estimated AP and estimated number of excess cases parameters. The lower level of RR value might be achieved if some control strategies for reducing NO_2 emission be used. Therefore the higher RR value can depict mismanagement in urban air quality. In the present study approximately 3 percent of total cardiovascular mortality, acute myocardial infarction and hospital admission of COPD happened when the NO_2concentration was over20µg/m³. Low percentage of observed health endpoints was associated to low concentration of measured NO_2 and as it mentioned NO_2 concentrations was lower than WHO and NAAQS guidelines.

Conclusion

In surgeries done on the nose, especially in aesthetic surgeries, efforts should be made to maintain the integrated structure of cartilage and as much as possible avoid manipulation and unnecessary cuts on the cartilage. In Suture technique, due to its non-destructiveness and minimum cartilage manipulation better results were obtained in the long term. It is recommended to apply VDD as the initial surgery method in sever deformities which cannot be corrected using Suture technique.

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