RESEARCH ARTICLE

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Effects of PM_{10} on Human Health in the Western half of Iran (Ahwaz, Bushehr and Kermanshah Cities)

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A-B-S-T-R-A-C-T

Background & Aims of the Study: Particulate matter pollutants have harmful effects on human health and can intensify mortality and disease. The aim of this study is evaluate to adverse health effects caused by exposure to PM_{10} in Ahwaz, Bushehr and Kermanshah Cities during 2011.

Materials & Methods: In this study, the Air Q2.2.3 model was used for estimated adverse health effects of exposure to PM_{10}. Air Q model provided by the WHO European Centre for Environment and Health (ECEH). Air Q software proved to be a valid and reliable tool to estimate the potential short term effects of air pollution. Daily concentrations of PM_{10} were taken from Department of Environment (ADoE). Then processing data's and finally the cardiovascular and respiratory disease attributable to this pollutant were calculated. **Results:** Results show that the non hospitalized patients suffer from the cardiovascular and respiratory diseases attributable to Pm_{10}. The patients from Ahwaz allocate the highest rate of hospital admittance to themselves with 19% respiratory and 20% cardiovascular charts those from Bushehr refer to hospitals 14% for respiratory illness and 15% for cardiac disease and the subjects from Kermanshah go to the hospitals 12% for respiratory complications and 14% for cardiac failures.
Conclusions: The results indicate a direct relationship between the concentration of PM_{10} and health effects resulting from exposure to them. The highest rate belongs to Ahwaz becomes it has greater concentration of dusty air. Therefore, the higher relative risk value can depict mismanagement in urban air quality.

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Background

Air pollution as an old and a new concern is threatened mankind health in both developing as well as developed countries (1,2). Globally, 3.7 million deaths due to ambient air 47 pollution were reported in 2012 that includes 6.7% of the total death (3). According to the estimates made by the world health Organization, 800,000 persons suffer from the untimely death due to the effects of cardiovascular and respiratory diseases and lung cancer caused by the air pollution throughout the world annually. Approximately 150000 losses occur in the south of Asia (4-7). Epidemiologic evidences which show the relationship between ambient air pollution and adverse health effect (8). Short and Long term exposure to PM_{10} can cases irritate the lungs, immune responses, lung constriction, producing shortness of breath, damage cells, aggravated coughing, aggravated asthma, increase hospital admissions, chronic bronchitis, cancer and deaths (9-12). Results in some studies insist on the point that the long -term contact with particulate matters leads to the decrease of life expectancy. The significant finding refers to the fact that when the air becomes polluted with dust, the rate of cardiac and pulmonary diseases increases 12% and 14% in a row. The models specifying the hygienic effects are mainly statistical and epidemiological. They combine the air quality data with epidemiological parameters such as the relative risk, the basic incidence and its attributable parts in the concentration intervals; as a result, they display the output in the form of death toll (13-15). Based on the standpoint stated by the public hygiene, the particulate matters are the main air pollutants. The world health Organization has estimated that 500000 individuals experience the untimely death annually owing to their encounter with the air particulate matters existing in the open air. In lieu of increasing every 10 microgram of the particulate matters, the rate of mortalities rises from 1 to 3 percent. Furthermore, the organization has appraised that the annual cost spent for the health and hygiene sector was about 30 billion pounds in Austria, France and Switzer land. It is equal to 6% of the whole death toll. It has also been assessed that the united states spend 23 billion pounds in the hygiene sector for the high concentration of the particulate matters annually (16-18).

In Iran, in a study carried out in zabol, it has been revealed that the cost of the respiratory diseases caused by the dusty air phenomenon has been more than 70 million dollars. Each individual will inhale 6.6240 grams of dust at the time of 10 – hour dusty air on average if they are active for 10 hours and breathe in 17 times per minute and average dust pollution of 0.0368 grams per cubic foot in the breathing air (19,20). The particles containing toxic substances can have severe effects on the different cells of the lungs and lead to the cell death. If the dead cells are not replaced by the live and new cells, the amphism disease may be created. The disease leads to depletion or extinction of the walls in bubbles. If the area of the bubbles is reduced, the lung capacity for the exchange of the gases will be weakened.

It should be noted that the cells of the respiratory system become remedied or replaced more slowly than those of other organs of the body (for instance the coating cells of the digestive system). The sediment or the deposit of some microbe agents and particles cause the lungs inflame or swell. If the inflammation and swelling occur in the nasal organ or bronchus, they are called rhinitis and bronchitis. If the inflammation pervades the lung parenchyma, it will be known as pneumonia. Ultimately, the chronic inflammation of the lungs could result in fibrosis (4,21). Ahwaz, Kermanshah and Bushehr roughly have populations of 969843, 843117 and 181674 individuals in succession. This cites are located in the west and south of Iran. Recently they have been exposed to the inadvertent dust which has made the living

difficult and unbearable to the citizens (6,17,21-23).

Aims of the study: The aim of this study is to evaluate adverse health effects caused by PM_{10} exposure in Ahwaz, Bushehr and Kermanshah Cities during 2011.

Materials & Methods

In this study, we using the Air Q software provided by the WHO European Centre for Environment and Health (ECEH) for estimated hygienic effects of exposure to PM_{10} on citizen three cities Ahwaz, Kermanshah and Bushehr. It should be mentioned that the collected data are for the year 2011. Required data of PM_{10} for model was collected in the form of EXCEL file from air quality monitoring stations in three megacities of Iran, Ahwaz, Bushehr and Kermanshah. We calculated cardiovascular and respiratory diseases attributable to PM_{10} pollutant based on relative risk (RR), Attributable proportion (AP) and baseline incidence (BI) by using Air Q model (24). Air Q model is based on statistical equations. In statistics and mathematical epidemiology, relative risk is a ratio of the probability of the event occurring in the exposed group versus a non-exposed group (2).

The relative risk for the selected health outcome can be derived from the exposure response function obtained from epidemiological studies.

Attributable proportion was calculated as following formula:

AP= SUM {[RR(c)-1] p(c)} /SUM [RR(c) p(c)]

Where: p(c) is population of city

Attributable proportion was multiplied at baseline incidence and divided to 105. The results will be the excess cases of cardiovascular and respiratory diseases attributed to given pollutant (PM_{10})(25).

Description the area of study

Ahvaz, the most 75 polluted city in view of PM_{10} annual average value, and also from strategic point of view is very important for being in the vicinity of Iraq and abundance of gas and oil resources. Ahvaz with an area of 8152 square kilometers, the capital of Khuzestan province extends over between 48 to 49 degrees and 29 minutes of the eastern longitude in the Greenwich meridian and 30 to 32 degrees and 45 minutes of the northern latitude from the equator (26).

Kermanshah, the capital cities of Kermanshah provinces, respectively. Kermanshah city is located in the central part of Kermanshah province with the position of 47 degrees and 4 minutes of the east and 19 degrees and 34 minutes of the north (26).

Bushehr port is the capital of Bushehr province. It is located in the west of the province and extends over an area of 1441 square kilometers. Its geographic an limits are specified by 50, 83710from the east and 28, 9576 0 from the north (17). Location of the study area has shown in Figure1.

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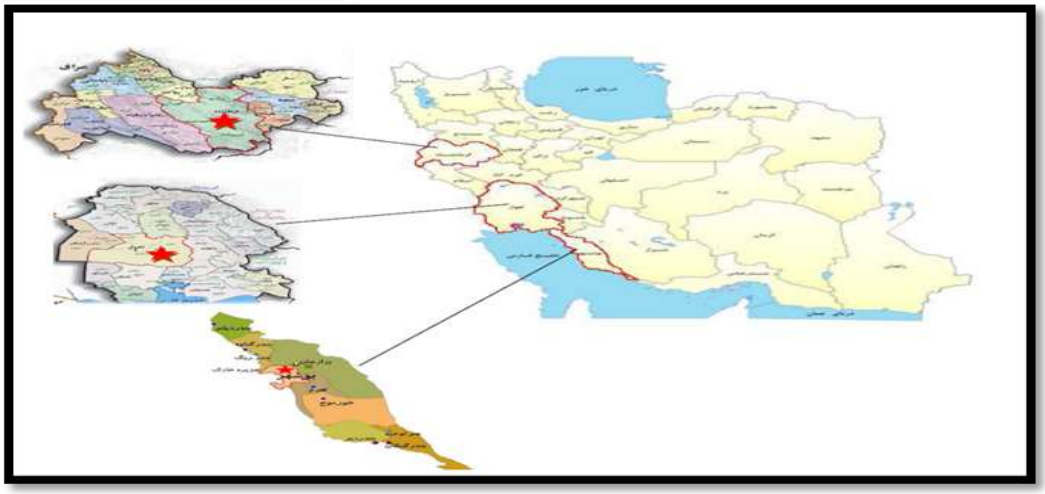

Figure 1) Location of the study area in the south west of Iran (Ahwaz, Bushehr and Kermanshah)

Results

Table 1 shows that the concentration of particulate matter in three city. The average concentration of particulate matter in Ahvaz higher than Bushehr and Kermanshah.

Table 1) PM_{10} Concentration in µg/m^3 to be used in the model (Ahvaz, Bushehr and Kermanshah, 2011)

(PM_{10}) Parameter	Bushehr	Kermanshah	Ahwaz
Annual Average	234.23	174.26	323.78
Summer Average	241.15	214.81	361.18
Winter Average	227.09	132.12	283.89

Table 2 shows that the commutative number of cases related to respiratory diseases estimating in three point of relative risk (RR=1.0048, 1.008, 1.0112) and the rate of baseline incidence (BI=1060 per 105 individuals). Approximately 50 percent of the cases in Ahvaz had occurred in the days when the PM_{10} concentration has not surpassed 300 µg/m^3. This Table showed that the cumulate number of respiratory disease cases turns out table 1262 persons in estimating the medium point of relative risk (RR=1.088) in Kermanshah during 2011. Approximately, 74 percent of those cases have occurred during the days when PM_{10} concentration has not surpassed 250 µg/m^3. It has to be observed that 1262 subjects have all been attributable to their contact with PM_{10}. The digits 10634 are better justified for Kermanshah in case the total number of cases relevant to the respiratory disease patients is considered in their references to hospitals. Also based on Table 2, the cumulative number of respiratory disease cases tends to be 310 applicants when the Medium point of relative risk (RR=1.008) 310 persons were estimated.

Table 2) Index estimation of relative risk, attributable proportion of PM_{10} for respiratory diseases referring to hospitals (BI=1260) (Ahvaz, Bushehr and Kermanshah, 2011)

Estimation	Relative Risk	Attributable proportion	Cumulative number of cases
Ahvaz	Low(1.0048)	12.0968	1476.9
	Medium(1.008)	18.6568	2277.9
	High (1.0112)	27.1513	1147.1
Bushehr	Low(1.0048)	8.6309	169.8
	Medium(1.008)	13.6021	310.2
	High (1.0112)	18.0603	411.9
Kermanshah	Low(1.0048)	7.4842	795.0
	Medium(1.008)	11.8809	1262.0
	High (1.0112)	15.8786	1686.6

Table 3) Estimation of the indexes for the relative risk, attributable proportion to PM_{10} for cardiovascular disease referring to hospitals (BI=436) (Ahvaz, Bushehr and Kermanshah, 2011)

Estimation	Relative Risk (High)	Attributable proportion	Cumulative number of cases
Ahvaz	Low(1.006)	14.6772	620.1
	Medium(1.009)	20.5106	866.5
	High (1.013)	27.1513	1147.1
Bushehr	Low(1.006)	10.5607	83.3
	Medium(1.009)	15.0465	118.3
	High (1.013)	20.3716	160.8
Kermanshah	Low(1.006)	9.1834	337.5
	Medium(1.009)	13.1704	484.1
	High (1.013)	17.9719	660.6

Table 3 indicates that the cumulative number of the cardiac disease cases in three point of relative risk (RR=1.006, 1.009, 1.013) and the rate of baseline incidence (BI=436 per 105 persons) in Ahvaz, Bushehr and Kermanshah during 2011. Numbers of the cardiovascular disease cases in Ahvaz were 868 persons.

Table 3 shows that estimate the numbers of the cardiovascular disease in Kermanshah were 484 persons at medium point of relative risk (RR=1.009). Nearly 74 percent of these cases have taken place during the days when PM_{10} concentration has not trespassed 250 $\mu g/m^3$.

Also, this Table reveals that the number of cardiac disease cases were calculated 118 persons in Bushehr when the medium point of relative risk. It should be noted that 118 applicants have all been attributable to the contact with PM_{10}.

Figure 2 shows cumulative number of cases of cardiovascular and respiratory diseases attributed to PM_{10} during 2011. According to Figure 2 within the certain concentration interval, the number of respiratory diseases was more than cardiovascular diseases. It showed that when the number of days with higher concentration of PM_{10} increased then the number of respiratory diseases increased more than cardiovascular diseases.

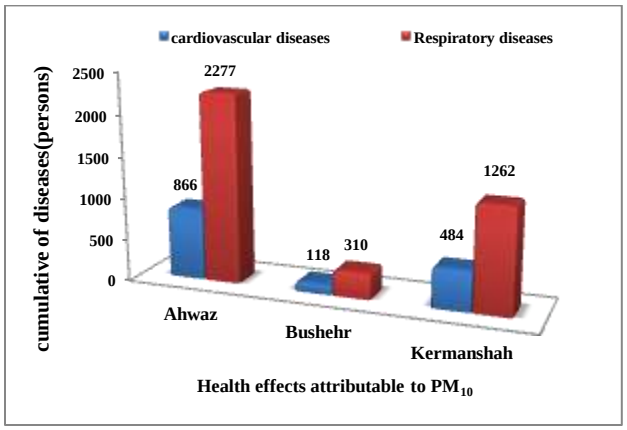

Figure 2) Cumulative number of cases for cardiovascular and respiratory diseases due to PM_{10} concentration intervals in 2011

Discussion

The results showed that the increase and decrease in the PM_{10} concentrations had meaningful relationship with its health effects which can be expressed by formula. In the past two decades the number of the air pollution study which focused on human health increased and now we focused estimated the number of cardiovascular and respiratory diseases attributed to PM_{10}. Table 2 shows that the approximately 50 percent of the cases have occurred in the days when the PM_{10} concentration has not surpassed 300 $\mu g/m^3$. It should be noted that the whole 2277 persons are attributable to the contact with PM_{10}. The number of the patients suffering from the respirator diseases attributable to the contact with PM_{10} roughly involves 18.65 percent of

the total cases going to hospital for the same hygienic consequence. Also, indicates about 50% of the cases have occurred during the days when PM_{10} concentration has not higher 300 $\mu g/m^3$. Based on result showed in Table 2 it has to be observed that 1262 persons have all been attributable to their contact with PM_{10} in Kermanshah. In this regard, the number of the applicants to hospitals for the respiratory diseases attributed to the contact with PM_{10} is about 11.88 percent of the total cases. About 60 percent of these cases have happened during the days when the PM_{10} concentration has not trespassed 300 $\mu g/m^3$. In this regard, applicant number of the respiratory diseases attributed to the contact with PM_{10} is about 13.6 percent of the total cases with the same hygienic consequence. Based on this results respiratory disease in Ahvaz was maximum among studied cities in 2011.

To explain Table 3 which is the program's output it should be noted that the estimated number of excess cases refers to cases of cardiovascular diseases caused by PM_{10} exposure. For example the cumulative number of cardiac disease estimated by Air Q model were 866 cases in Ahvaz, 118 cases in Bushehr and 484 cases in Kermanshah. In this regard, the number of cardiovascular disease applicants attributable to the contact with PM_{10} has been 15 percent of the total applicants with the same hygienic consequences. In 2011, of the three research setting, Ahvaz with concentration 323.78 $\mu g/m^3$ was the highest annual mean; whereas, Bushehr and Kermanshah have appropriated with rate of annual concentration 234.23 $\mu g/m^3$ and 174.24 $\mu g/m^3$ (the lowest) for themselves. Studies done in 29 European cities, 20 American cities and some cities of the Asian countries, represent the fact that the hygienic effects related to the short term contact with PM_{10} appear to be identical in the different cities of the developed countries and developing ones, furthermore, in lieu of each 10 $\mu g/m^3$ increase of daily PM_{10} concentration the rate of death risk rises up to 5 percent. Thus, 150 $\mu.g/m^3$ concentrations are interpreted as 0.5 percent increase of daily death toll (27,28). The surveys and meta analysis carried out to determine the short term effects on mortalities uncovered that with 10 $\mu g/m^3$ increase (with certainly intervals of 95 percent), the estimated rate of the effect is given as follows: 1.7 percent in Bankok (1.1-2.3%) (29), Mexico City 1.83 percent (0.9-2.7%) (30), Santiago 1.1% (0.9-1.4 percent) (31), Inchan 0.8% (0.2-1.6 percent) (32), Brisbin Australian 1.6% (0.5-2.6 percent) (33), Sidney 0.95 percent (0.32-1.6 percent) (34). Reports have also been made concerning the estimate of respective mortality with PM10 or TSP from Shin Yang of China (35). Seven cities of South Korean (36) and new Dehli (37). It is discerned that the current investigations have been performed in the cities where the basic situations such as population, climate, the use of smoke, chimneys of houses, occupational encounter socio-economic conditions and PM_{10} concentration have varied greatly and involved an extensive spectrum. As a result, it seems reasonable to generalize the available data into the areas where studies have not curried out. For example, the projects done in Mexico sixty, Bangkok and Santiago were reported to have the average PM_{10} concentration of 45.65 and 115 $\mu g/m^3$.The maximum concentration have also been 121.227 and 360 $\mu g/m^3$ .Mean while ,the relationship of response concentration would probably get out of the linear state. So, to follow the prudence, the range of linear assumption needs to be restricted. These research projects provide the convincing witnesses all in all. Based on their implication, PM_{10} plays a significant role in increasing the mortality. Although the relative risk comes down for every individual, a lot of people are exposed to the concentration which means PM_{10} has a crucial effect on the public health. Based on a regression model of examining the air pollution in ten cities of the United States, Schwartz has calculated that the relative risk for the adults older than 65 would be two percent in lieu to each 10$\mu g/m^3$ increase of PM_{10}. (38).

In 2005, Tominez et.al utilized the Air Q model to assess the PM_{10} hygienic effects on Trusty in Italy. According to the results obtained from the research 1.8 percent of the total cardiovascular mortalities and 2.5 percent of the respiratory mortalities were attributed to the concentrations higher than 20 µg/m^3 (39). In 2008, Goudarzi et.al exploited Air Q model to estimate the PM_{10} hygienic effects on Tehran. Based on the results they produced, about 4 percent of the whole cardiovascular and respiratory mortalities is attributed to the concentrations greater than 20 µg/m^3 (40). In 2010, Mohammadi et.al used the Air Q to estimate the PM_{10} hygienic effects on Ahvaz. The obtained results of the survey indicated that nearly 13 percent of the total cardiovascular and respiratory mortalities are attributed to the concentrations higher than 180 µg/m^3 (41).

Conclusions

Clean air has an important role at health of citizens' in each city. The main objective of this study was to find relationship between concentration of PM_{10} and health problems in term of respiratory and cardiovascular diseases. Result this study showed that Air Q model is one of the most models for estimated health effects air pollutants. The result of this study showed that a respiratory and cardiovascular disease in all cases in Ahvaz was more than another cites. Results showed that attributable proportions for respiratory and cardiovascular diseases were 19% and 20% in Ahvaz, 14% and 15% in Bushehr, 12% and 14% in Kermanshah. The reason Ahvaz had the highest rate due to higher concentration of PM_{10} related to industries and dusty air as well as further duration of polluted air in the city. Therefore, urgent actions have to be taken to reduce emissions from various sources such as transport and energy production sources in Ahvaz.

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Footnotes

Conflict of Interest:

The authors declare no conflict of interest.

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