RESEARCH ARTICLE

•Arch Hyg Sci 2015;4(2):64-72
•Journal Homepage: http://jhygiene.muq.ac.ir

Determination of Behavior Particulate Matter Less Than 10 Microns and Effects on Human Health in Ahvaz, Southwest Iran in 2013

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A-R-T-I-C-L-E I-N-F-O

Article Notes:
Received: Jan 18, 2014
Received in revised form: May 2, 2015
Accepted: May 18, 2015
Available Online: Jun 5, 2015

Keywords:
Particulate Matters
Human health
PM_{10}
Respiratory diseases
Ahvaz, Iran

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

Background & Aims of the Study: Particulate matter concentrations is the component of one of greatest concern for human health and refer to fine suspended particulates less than 10 microns in diameter (PM_{10}) that are capable of penetrating deep into the respiratory tract and causing significant health damage. Particulate matters less than 10 microns can absorb into your lungs and reacting with the moisture and enter the circulatory system directly through the airways. The aim of this study is to assess behavior PM_{10} data in different seasons and determination effects on human health in Ahvaz city during 2013.

Materials & Methods: Data particulate matters less than 10 microns were taken from Ahvaz Department of Environment and Meteorological Organization. Sampling was performed for 24 hours in 4 stations. Method of sampling and analysis were performed according to EPA guideline. Data behavior were evaluated over time in different seasons by processing data by Excel software. Processing data include the instruction set correction of averaging, coding and filtering. Finally, health-effects of particulate matters less than 10 exposures were calculated with impact of meteorological parameters and converted as input file to the Air Q model.

Results: Based on this results PM_{10} concentration in winter season was maximum amount in the year 2013. According to the research findings, highest and the lowest Particulate matters less than 10 microns concentrations during 2013 was in the Meteorology and head office of Ahvaz Department of Environment. Sum of total numbers of cardiovascular death and hospitals admission to respiratory diseases attributed to particulate matters less than 10 microns were 923 and 2342 cases in 2013 respectively.

Conclusions: Particulate matter emissions are highly regulated in most industrialized countries. Due to environmental concerns, most industries and dust storm phenomena are required to decrease in source produce particle mater and kind of dust collection system to control particulate emissions. Pollution prevention and control measures that reduce Particulate matters less than 10 microns can very useful for expected to reduce people's exposures to Sulfur dioxide.

Please cite this article as: Geravandi S, Goudarzi Gh, Vosoughi M, Salmanzadeh Sh, Mohammadi MJ, Zallaghi E. Determination of Behavior particulate matter less than 10 microns and effects on human health in Ahvaz, southwest Iran in 2013. Arch Hyg Sci 2015;4(2):64-73.

Background

In the recent years, increasing concentration of air pollutants has become effect an increased damage to environment and the rate of morbidity and mortality on human (1-4). Particulate matter (PM) is microscopic solid or liquid matter suspended in the Earth's atmosphere (5). The main sources of particulate matter can be atmospheric particle matter include suspended particulate matter (SPM), respirable suspended particle (RSP), fine particles (FP), ultrafine particles (FP) and soot. Another most source them include volcanoes, forest and dust storms. Burning of fossil fuels, power plants and industrial processes also generate significant amounts of PM (5-6). Air pollution is one of the important threats for human health (2). Based on result different studies short and long term exposure to air pollutants can cause concerns regarding public health (7-10). According the results several studies increase air pollutants especially PM_{10} because of enter the circulatory system directly through the airways raised number of hospital admission, repository and cardiovascular disease, asthma attacks, lung cancer and number of deaths (11-19). Particulate matters are the ability to penetrate deep into the lungs and permanent DNA mutations (20-22). From past to now, Ahvaz has been well known due to industries as well as environmental pollution. Social impacts of air pollution on Ahvaz citizens were also evaluated (23,24). In the last decade, dust storm, rapid economic growth in Ahvaz, industrial emissions has joined to other environmental problems (23,24). Furthermore, health endpoint of PM_{10} in Ahvaz was reported (22-24). According to study in Shiraz, Iran investigate PM_{10} dispersion were measured in four locations, as an instance, weekly average (25). Based on result Jaworsski et al particulate matter is exceeding international guidelines in some seasons (26). Wu et al in in the winter of 2003–2004 were measured The size distributions of PM_{10} in aerodynamic diameter by using a nine-stage low-volume cascade impactor at rural and urban sites in Tianjin, China in (27). Based on results of study World Health Organization, increased by 10 micrograms of Particulate matters, the mortality rate of 1 to 3 percent increases (28). Isabelle study showed that when an increase of 20 $\mu g/m^3$ Particulate matters, the risk of death was increased by 82 percent (29). Result study in the eight major Italian cities showed that when an increase of 30 $\mu g/m^3$ Particulate matters, about 3500 deaths and cases of disease were attributable (30). Particulate matter studies in Bangkok Thailand from 2008 indicated a 1.9% increased risk of dying from cardiovascular disease, and 1.0% risk of all disease for every 10 micrograms per cubic meter (31). Goudarzi et al in Tehran, quantifying the health effects of air pollution by using AirQ model (32). Another study Zallaghi et al in Tabriz showed a relationship between health impact and particulate matters less than 10 microns by using AirQ Model (23). In 2013, a study involving 312,944 people in nine European countries revealed that there was no safe level of particulates and that for every increase of 10 $\mu g/m^3$ in PM_{10}, the lung cancer rate rose 22% (33). A 2014 meta analysis reported that long term exposure to particulate matter is linked to coronary events. Based on result this study, an increase in estimated annual exposure to particulate matters of just 5 $\mu g/m^3$ was linked with a 13% increased risk of heart attacks (34). The World Health Organization (WHO) estimated in 2005 that, fine particulate air pollution particulate matters, causes about 3% of mortality from cardiopulmonary disease, about 5% of mortality from cancer of the trachea, bronchus, and lung, and about 1% of mortality from acute respiratory infections in children under 5 years, worldwide (35). The largest US study on acute health effects of coarse particle pollution between 2.5 and 10 micrometers in diameter. Was published 2008 and found an association with hospital

admissions for cardiovascular diseases (36). AirQ software was proved to be a valid and reliable tool to estimate the potential short-term effects of air pollution, predicts health endpoints attributed to criteria pollutants, and allows the examination of various scenarios in which emission rates of pollutants are varied (37).

Aims of the study: The aim of this study is two main parts, Determination particulate dispersion and effects on human health in Ahvaz city during year 2013 (located in south-western Iran).

Materials & Methods

The present study is an epidemiological. In this study, we used Air Q model study and assess the health effects of PM_{10} exposure on human in Ahvaz city (located in south-western Iran) during year 2013 Sampling don by Ahvaz Department of Environment and in Ahvaz there were 4 sampling point for measure air pollutants (2). Sampling was performed for 24 hours in 4 stations. Method of sampling and analysis were performed according to EPA guideline. In this study 35040 samples of Ahvaz's air was taken and collected in during year 2013. Pollutant concentrations of PM_{10} were measured using GRIMM. The most important part of analysis is data processing that encompasses modification of temperature and pressure, primary processing (the deletion, spreadsheet and synchronization), secondary processing (writing code and condition correction), formulation and filtering. We calculated cardiovascular death, respiratory mortality and Hospitals admission to respiratory diseases related to PM_{10} by AirQ2.2.3 based on the utilizing relative risk, attributable proportion and baseline incidence from WHO data (2). This model includes four screen inputs (Supplier, AQ data, Location, Parameter) and two output screens (Table and Graph) (16). For estimated of health impact attributable to the exposure of air pollution on the target population using AirQ model, that estimate the this impacts to specific air pollutants on a resident population in a certain area and period. The primary and secondary standard of particulate matter according to national ambient air quality standard (NAAQS) 24-hour is 150 $\mu g/m^3$ (37). The standard of particulate matter according to European Air Quality Standards (EU AQS) 24-hour is 50 $\mu g/m^3$ and 1 year is 40 $\mu g/m^3$ (38).

Description of study area: Ahvaz city, with a population of 1 million approximately, with an area of 8152 square kilometers, the capital city of Khuzestan Province is located between 48 degree to 49°29′ east of Greenwich meridian and between 31 degrees and 45 minutes to the north of the equator (2,16). To perform this study data was taken from Ahvaz Department of Environment (ADoE). Stations were Downtown (Naderi), Old School of Public Health (BehdashtGhadim), Meteorology (Havashenasi) and Head office of ADoE (Mohitzist). Location of the study area and sampling station in Ahvaz city shows in Figure 1.

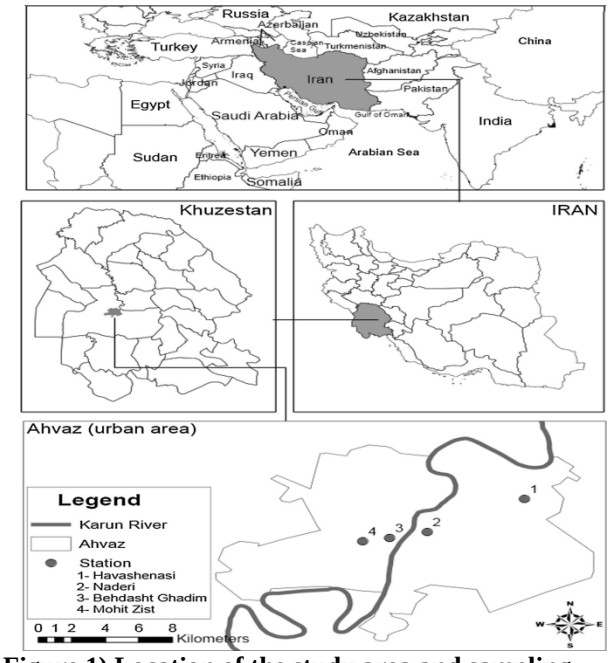

Figure 1) Location of the study area and sampling station in the Khuzestan Province (Ahvaz city), in the south west of Iran (24).

Data analysis: The results were reported as percentages.

Results

Based on the results of this study, highest and the lowest stations PM_{10} concentrations, Meteorology and Head office of ADoE were in during this year respectively. The yearly average, summer mean, winter mean and 98 percentile of PM_{10} concentrations in these stations has presented in table 1. During the year 2013 PM_{10} concentrations was higher in winter than in summer. Maximum annual concentration was observed in winter 2013 as 1854 µg/m^3. Table 1 shows that annual mean of PM_{10} in Ahvaz was 917 µg/m^3 in 2013 which is higher than NAAQS standards.

Table 1) the highest and lowest concentration of PM_{10} (µg/m^3) corresponding to stations for use in model.

Study Years / Parameters	Ahvaz city (2013)	lowest stations (Head office of ADoE)	highest stations (Meteorology)
Annual mean	917.12	420.18	1320.24
Spring mean	666.58	345.38	928.04
Summer mean	520.77	289.65	741.71
Autumn mean	648.17	318.32	918.22
Winter mean	1854.66	893.72	2635.11
Annual 98 percentile	5000	1546.84	5452
Annual Maximum	5760.00	2135.10	5760.00
Summer and Spring Maximum	5000.00	1026.36	5000.00
Winter and Autumn Maximum	5760.00	2135.10	5760.00

Figure 2 show average concentrations of PM_{10} in during seasons this year respectively. Based on this results PM_{10} concentration in winter season was maximum amount in the year 2013.
Relative risk (RR) and estimated Attributable Proportion (AP) percentage for cardiovascular death, respiratory mortality and Hospitals admission to respiratory diseases were calculated in table 2. According to model's default, the baseline incidence (BI) of this health endpoint for PM_{10} were 497, 66 and 1260 per 100,000 people, so, the number of estimated number of excess cases were estimated 923 for cardiovascular death at centerline of relative risk (RR=1.008 and AP=19.16%) and 2342 for hospitals admission to respiratory diseases at centerline of relative risk (RR=1.008 and AP=19.16%).
Figure 3 shows the cumulative number of cardiovascular death and hospitals admission to respiratory diseases versus PM_{10} concentrations. 62 percent of cardiovascular death number has occurred in the days with PM_{10} concentrations lower than 90µg/m^3. Also Figure 3 shows that 72% of hospitals admissions to respiratory diseases number are corresponded to the days with concentrations below 250µg/m^3.

Table 2) Estimated relative risk indicators and the component attributable to PM_{10} cases attributable to cardiovascular death and hospitals admission to respiratory diseases

Health effects attributable to	RR (relative	Estimated AP (%)	Estimated number of
Cardiovascular death	1.008	19.16	923.8
Hospitals admission to	1.008	19.16	2342.1

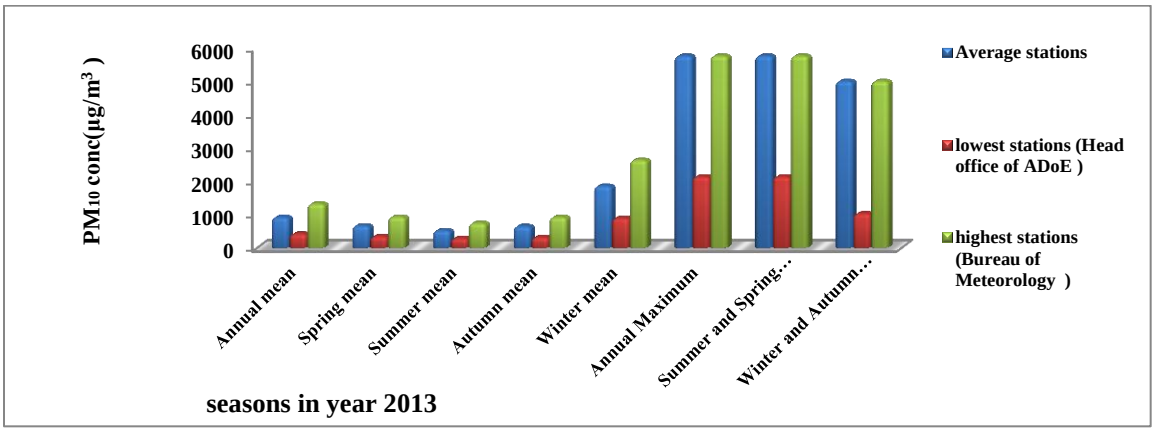

Figure 2) relationship between PM_{10} concentration and seasons in year 2013

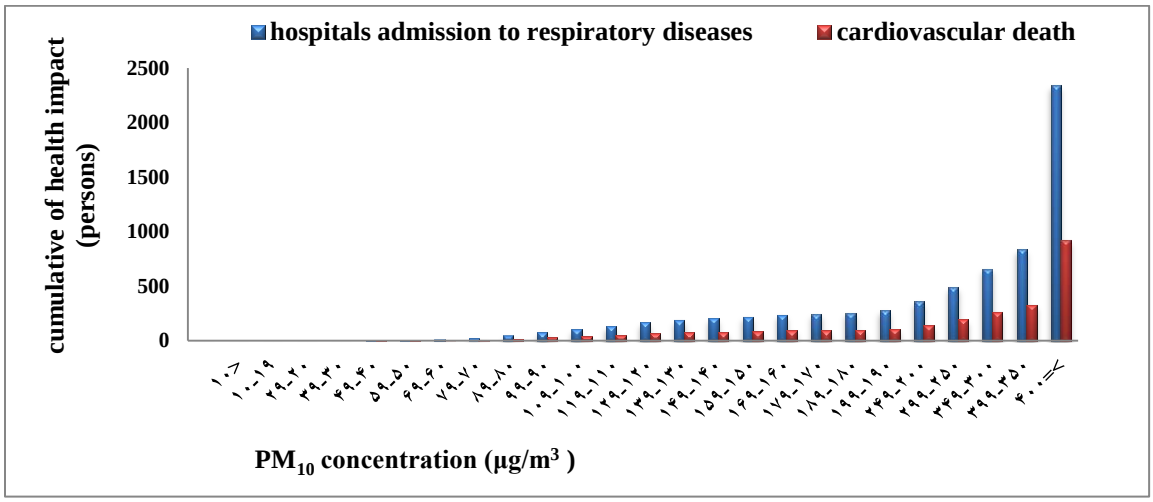

Figure 3) relationship between cumulative number of health impact and PM_{10} concentrations

Discussion

The result showed that the maximum concentration was Meteorology station and the minimum in Head office of ADoE station. Average concentrations of PM_{10} in during seasons in showed Figure 2. Based on result this study PM_{10} concentration in during Spring and winter seasons because of condition Meteorological, industrial and dust storm phenomena is higher than another seasons in during year 2013. Sum of total numbers of cardiovascular mortality attributed to PM_{10} was 923 cases and number of hospitals admission to respiratory diseases versus PM_{10} in high relative risk was 2853 cases that 61 percent of them happened when the PM_{10} concentration was less than 120 µg/m^3. Relative risk and estimated Attributable Proportion percentage for cardiovascular death and hospitals admission to respiratory diseases were calculated in table 2. Baseline incidence (BI) for this health endpoints for PM_{10} were 497, 66 and 1260 and per 105 at centerline of relative risk. Results show that approximately Ahvaz with 7 percent is one of the most polluted cities. The higher percentage of these deaths perhaps could be the result of higher average PM_{10} or because of sustained high concentration days in Ahvaz. Figures 3 have illustrated PM_{10}

concentrations versus related health endpoint and average concentrations in during years. In this study, we estimate cardiovascular death, respiratory mortality and hospitals admission to respiratory diseases were associated with short and long term fluctuations in concentrations of PM pollutant in people, using AirQ model in Ahvaz, Iran. Based on the results of this study, approximately 14.6, 9.6 and 17.8 percent of total cardiovascular death, respiratory mortality and hospitals admission to respiratory diseases were attributed to respiratory PM_{10}. The association of daily mortality and morbidity with short-term variations in the ambient concentrations of air pollutants (39). The most number of the days with exposure to PM_{10} in Ahvaz in 2013 was related to concentrations above 400 $\mu g/m^3$ with most death cases due to cardiovascular and respiratory death. Tominz and Associates to evaluate the health effects of PM_{10} by using of Air Q model in Trieste city during 2005, Italy. Based on the results of this study, 1.8 percent of all respiratory mortality and 2.5 percent of all deaths were attributed to respiratory concentrations over 20 $\mu g/m^3$ (40). The results this study shows that concentration of PM_{10} in Ahvaz is very high compared to Trieste city. Review and meta-analysis was conducted to determine the effects of short-term exposure on mortality that increasing 10 $\mu g/m^3$ showed estimated by the Mexico 1.83 percent, Santiago 1.1 percent, Inchoan, 0.8 percent, Bryson Australia 1.6 percent (41-44). High percentage of the observed health endpoints in this study was associated with high concentration of measured PM_{10} and phenomenon dust storm in Ahvaz. In similar work Goudarzi et al In 2009 estimate the PM_{10} hygienic effects in Tehran (capital of Iran). Based on the results of this study, 4 and 5.6 percent of all respiratory mortality and cardiovascular death was attributed to PM_{10} concentrations over 20 $\mu g/m^3$ (32). Concentration of PM_{10} in Ahvaz is very high compared to Tehran city. Results of this study are different to compared with Tehran because of the geographic, demographic, and climate characteristics. In another study, Mohamadi et al In 2009 calculated health effects air pollutants in Ahvaz. Based on their results, approximately 4.35 percent of total cardiovascular death and 2.2 percent myocardial infarction related to PM_{10} (45). According to one study in Six Italian cities showed that with an increase in the pollutant levels of 10 $\mu g/m^3$ of daily average of PM_{10} was associated with an increase 2.8 percent in cardiovascular disease (46). Results of this study are different to compared with six Italian cities because of the geographic, demographic, and climate characteristics. In similar work, Zallaghi exploited AirQ model to estimate the PM_{10} hygienic effects in Bushehr during 2010. Based on their results, almost 14 percent of cardiovascular diseases and 19 percent Respiratory diseases was attributed to PM_{10} concentrations over 20 $\mu g/m^3$ (47).

Based on the results of my study, number of cases Health effects was the relatively higher because of concentration greater in Ahvaz city. Results of my study showed that dust storm and having oil, petroleum and steel industries are the most important factors incidence of health endpoints attributed to PM_{10} in Ahvaz.

Conclusion

In the present study, a detailed data's analyzed was carried out to find out the pattern of particulate dispersion in during different seasons 2013 in Ahvaz. Based on the results obtained in this study the amount of particles in during spring and winter seasons is higher than another season in during year 2013. Also, High percentage of the observed health endpoints was associated with high concentration of measured PM_{10}, and as it was mentioned previously, PM_{10} concentration was higher than EU AQS and NAAQS guidelines' values. It is recommended to make using methods for decrease particles in source at Neighboring

countries, actions to reduce emissions to air in industrial, alternative energy sources such as solar cooking and electrical heating, appropriate health and environmental monitoring, can are effective in decrease PM_{10} concentration. This study adds another outcome to the increasing body of literature on the adverse reproductive health effects of exposure to PM_{10} in Ahvaz, Iran. Although the results of this study are in line with results of other researches around the world, since the geographic, demographic, and climate characteristics are different, there is still high need to further studies to specify local RR and BI. Unfortunately, due to lack of databases and the lack of indicators amounts the studied were used the values of the WHO (Middle East) for calculated health effects attribute PM_{10}. Pollution prevention action can generally be expected to reduce people's exposures to all gaseous PM_{10}. Thus, further studies that would allow assessing the development in health status are necessary.

Footnotes

Acknowledgments:
The authors would like to thanks of Ahvaz Jundishapur University of Medical Sciences for their financial support.
Funding/Support:
Ahvaz Jundishapur University of Medical Sciences supported this study.
Conflict of Interest:
The authors declare no conflict of interest.

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